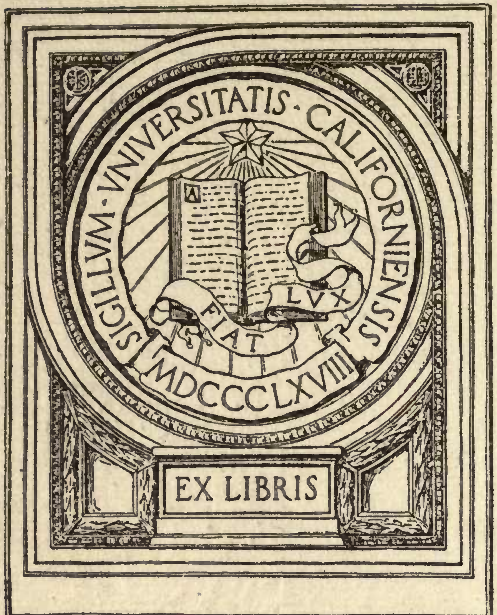
SIGILLVM · VNIVERSITATIS · CALIFORNIENSIS
LVX
FIAT
MDCCCLXVIII
EX LIBRIS

NUTRITION AND DIETETICS

NUTRITION AND DIETETICS

A MANUAL FOR STUDENTS OF MEDICINE, FOR TRAINED NURSES, AND FOR DIETITIANS IN HOSPITALS AND OTHER INSTITUTIONS

BY

WINFIELD S. HALL, PH.D., M.D.

PROFESSOR OF PHYSIOLOGY, NORTHWESTERN UNIVERSITY MEDICAL SCHOOL; LECTURER ON PHYSIOLOGY AND DIETETICS IN MERCY HOSPITAL AND WESLEY HOSPITAL, CHICAGO

NEW YORK AND LONDON
D. APPLETON AND COMPANY
1911

Published January, 1910

Printed in the United States of America

PREFACE

DURING more than ten years the author has been presenting the subject of nutrition and dietetics to classes of undergraduates in medicine and to the nurses of two large city hospitals.

Both lecturer and students have found much valuable literature for reference, notably such works as Thompson's "Practical Dietetics" and the publications on nutrition and dietetics issued by the Government Experiment Stations.

There has been a repeated request for a concise text-book suitable not only for undergraduates and nurses, but also for the general practitioner, and covering the whole field of *nutrition and dietetics.* But no such book seemed available.

Any rational and strictly scientific system of dietetics must necessarily be based upon the most recent researches on animal nutrition. Hence a text-book of dietetics should contain a brief statement of the laws of nutrition.

To devote a large part of the volume to recipes seems wholly unnecessary, as the physician does not need them and the nurse already has them in her books of recipes, so called.

The little volume here presented is the growth of a decade of teaching, and represents practically the course as now given to undergraduates and nurses by the author and his associates, and in it we trust that a real need is supplied.

The author takes this opportunity to acknowledge the valuable contribution to the volume made by Joseph Brennemann, Ph.B.,

M.D., Assistant Clinical Professor of Pediatrics, Northwestern University Medical School. Professor Brennemann prepared Chapters XII and XIII, on Infant Feeding in Health and in Disease.

Valuable assistance was also received from Miss Helen Hammel, former dietitian at Wesley Hospital, in the preparation of Appendix I, on Recipes.

WINFIELD S. HALL.

CHICAGO, December, 1909.

CONTENTS

PART TWO

THE USE OF FOODS IN THE BODY

PART THREE

DIET IN HEALTH

PART FOUR

DIET IN DISEASE

APPENDICES

INTRODUCTION

INTRODUCTION

The most interesting subject in the whole realm of human thought is life. One of the first things that an observing person notices is that the whole world may be divided into two realms: First, the realm of the living; second, the realm of the non-living. One picks up a clam and a pebble on the beach. The clam is living, the pebble is non-living. One glances at the moon shining through the foliage of a tree. The tree is living, the moon is non-living. One glances at his own body. His body possesses life, but the clothing which covers it does not possess life.

To the child the most interesting thing in the world is his own body, after he becomes conscious of it, and Nature endows every child with the instinct of self-preservation. One of the first things that the infant does is to seek for nourishment. This is purely instinctive and remains instinctive for months; even years later he is hardly conscious of the real significance of his periodical quest for food.

The instinct of self-preservation includes both defense of the body against danger and the quest for nourishment. While these two primary instincts seem to be of equal importance from a philosophical standpoint, the fact remains that we devote vastly more time and energy to the nourishment of our bodies than we do to their defense against danger. Thus, from a practical standpoint, the nourishment or the nutrition of the body may be looked upon as the most important thing in our everyday life.

The term "*nutrition*" is a somewhat technical one, and includes all those physiological processes associated with the material growth, repair, and supplies of the body. It begins with a consideration of the composition of the body, of the source of the materials which are used in body growth and repair and the preparation of these materials, of their change within the body, and finally of the ridding of the body of waste materials. The process of nutrition is so extended and complex that it is difficult

to define it in briefer terms than those just formulated above. If one were to attempt a concise definition, it would be as follows: *Nutrition is the physiological process of supplying the material needs of the body.*

The material needs of the body are supplied in the food and drink which we take into the stomach, and the oxygen which we inhale into the lungs. Food and drink make so important a part of the material needs of the body, and the choice and preparation of the foods are so important a part of the work of those who have the care of growing children, or of workingmen and women, or of invalids in hospitals, institutions, and homes, that the principles of such choice and preparation have been reduced to a science known as Dietetics. One would therefore define the science of dietetics as *a systematic presentation of food classification and food preparation, together with the principles which govern the choice of foods under various conditions, age, employment, health, or sickness.*

It must be evident that no one can gain a rational idea of nutrition and the special phase of nutrition called dietetics without a knowledge of the chemical composition of the body and of foods, also of the chemical changes which the foods undergo in the body. This knowledge of body chemistry or physiological chemistry, as it is usually called, is so essential that the early chapters of this brief work will be devoted to a concise presentation of the fundamental principles, including the most essential facts of physiological chemistry. It might be said in passing that the student of nutrition and dietetics should possess at least a general knowledge of the structure of the human body, more particularly that of the alimentary canal and the digestive system in general. Without this knowledge many of the statements of any work on nutrition and dietetics would convey only the vaguest ideas to the reader.

Furthermore, the student of dietetics should bring to the subject at least an elementary knowledge of chemistry, together with practical ideas or actual experience, in the methods of preparing and cooking foods in the kitchen.

PART ONE

FOODS

CHAPTER I

THE NEEDS OF THE BODY

A. THE CHEMICAL COMPOSITION OF THE BODY

WHEN man began first to think of the material composition of his body, he naturally assumed it to be composed of special and very precious materials. The science of chemistry has, however, step by step brushed away the superstitions of the mythologists and the mysteries of the alchemist, and revealed the fact that man's body is composed of the most ordinary elements, such as carbon, oxygen, hydrogen, nitrogen, phosphorus, sulphur, chlorin, sodium, potassium, magnesium, iron, and calcium. These elements will be recognized as the most widely distributed substances in nature. Carbon combined with oxygen, as carbon dioxid, makes an appreciable proportion of the earth atmosphere; oxygen itself makes about one fifth of the atmosphere, while nitrogen makes nearly four fifths. Hydrogen combined with oxygen in water is practically universal in its distribution, appearing on the surface of the earth, in seas, lakes, and rivers, forming great underground streams and strata in the surface rocks and soils of the earth, and floating in clouds, fogs, and vapors in the atmosphere. Those rocks which contain calcium, iron, magnesium, sodium, and potassium are most universal in their distribution. So we find that these substances of which man is constructed are universally distributed over the surface of the earth.

But man is not alone in the use of these widely distributed substances in his body. All living things on the earth, whether plants or animals, are constructed of these twelve substances.

Living things may be said to be made of the dust of the earth.

The questions that first come to the thoughtful mind are: What is the essential difference between living things and non-living things? What is the difference between a stalk of corn and the soil from which it grew? What is the difference between a clam and the mud in which it lives? What is the difference between a man and the rock on which he stands? A study of the chemical composition of the living and the non-living shows that the difference does not exist in the elements of which they are composed, but in the complexity of combination of these elements. The growing stalk of corn is composed of cellulose, chlorophyll, sugar, woody fiber, which represent complex combinations of carbon, hydrogen, nitrogen, oxygen, phosphorus, sulphur, chlorin, iron, potassium, calcium, and magnesia, while the soil and air in which the corn grew is composed of water (H_2O), carbon dioxid (CO_2), calcium carbonate ($CaCO_3$), nitrates (as $NaNO_3$ or KNO_3), phosphates (as $CaHPO_4$), chlorids (as $MgCl_2$), sulphates (as $CaSO_4$), together with many other simple compounds. Note that even the more complex molecules in the soil contain only a few atoms, while one of the simpler molecules in the corn is cane sugar ($C_{12}H_{22}O_{11}$), which contains forty-five atoms. Some of the more complex molecules of a growing stalk of corn represent probably not fewer than two or three thousand atoms. One may, therefore, sum up as follows:

The body is composed of twelve universally distributed elements (C, H, N, O, P, S, Cl, Na, K, Mg, Fe, Ca) combined in the most complex molecules, some of which contain many hundreds, even thousands, of atoms.

B. THE NEEDS OF THE BODY IN GROWTH AND REPAIR

A most obvious and direct inference from the facts set forth under the preceding section is that the body needs for its growth and repair such elements as enter into its construction. While this is true, we must not lose sight of the fact that while the growing corn plant needs carbon, it cannot use this element in the form of coal. Carbon to be available for the growth of a plant must be in the form of carbon-dioxid gas.

The animal needs nitrogen, but it is quite unable to use nitrogen in the form of the nitrates of the soil or the nitrogen gas of the air. Nitrogen to be available for animal uses must be built up into complex substances called proteins, examples of which would be egg albumen, lean meat, gluten of bread, etc.

While plants are able to build up complex substances out of the simple compounds of the earth and air, the animal is not so endowed, and is obliged to depend upon the substances built up by the plant kingdom, for example: starch, sugar, protein, fat, and salts. If we analyze the animal body, we find it composed largely of these substances. However, the greater part of the body is composed of proteins and salts. The proteins make up muscles, glands, and nervous system, while the skeleton is composed largely of deposited salts. It must be evident that to furnish such a body with the substances needed in growth and repair, it is only necessary to furnish a sufficient amount of proteins and salts to provide materials needed to build up the muscles, glands, nervous system, and skeleton.

C. THE NEEDS OF THE WORKING BODY

The body is analogous to an engine. The working engine needs fuel, whose oxidation supplies the heat required to set the engine in motion. In a similar way the working body requires fuel, whose oxidation furnishes the energy for the body movements. Engine fuels are the easily oxidized coal, wood, or oil. Body fuels are the easily oxidized starch, sugar, and fat. The oxidation of engine fuel liberates heat, which either directly or indirectly sets the parts of the engine into action. The oxidation of body fuel liberates heat, and at the same instant produces the energy peculiar to the active tissues of the body—in muscle tissue, motor energy; in glandular tissue, chemical energy; in nervous tissue, "nervous energy," closely related to if not identical with electrical energy.

Thus, we find that the body needs foods similar in composition to its own substance for growth and repair, while it needs

fuel foods from which to produce the active energy for the working body.

We will find later that these two phases of body requirements —growth and repair on one side and work on the other—make the basis for the classification of foods into two great classes, each class serving one of these fundamental requirements of the body.

CHAPTER II

NATURAL FOODS

A. FOODS FOR YOUNG PLANTS

In the previous chapter something was said of the food required by a growing corn plant after it has reached a stage in its development in which it is independent of the parent plant and is able to live on the elements of the soil and air. When this corn plant began its growth from the seed which the farmer planted in the ground, it led a very different life, and one typical of young plants in general.

The young corn plant lives upon the material provided for it by the parental organism, and stored away in the dry corn grain. When a dry grain is put into a warm, moist place it begins to swell and germinate. The young corn plant which has been lying asleep in the germ of the kernel is waked up by the warmth and moisture and begins to grow, taking its nourishment from the substance of the kernel. This nourishment consists of starch, oil, protein, and salts. The germinating corn plant digests these substances, dissolving them and making them a part of the plant's sap. From this sap, or circulating fluid, the young plant takes up the nourishing materials and assimilates them, or builds them up into plant tissues. After a few days of growth in the warm, moist soil of the field or garden the corn plant produces the bright-green pigment peculiar to most plants called chlorophyll. Through the help of this wonderful substance, chlorophyll, the growing plant is able to build up sugar and starch from the carbon dioxid of air and the water of the soil. It is able at this time to take up the nitrates, phosphates, sulphates, chlorids, and other salts of the soil, and build them up into the plant tissues, thus

becoming an independent living thing, able to maintain itself. It received its start in life from its parents, and thus became a debtor. It pays its debt to Nature by producing a numerous progeny of young corn plants, each one of which it supplies with a store of material to set it up in business.

To summarize, young plants that start from seeds consume a menu consisting of the following food materials: Protein, starch, sugar, fat, salts.

B. FOODS FOR YOUNG BIRDS

Young birds begin their development within an eggshell. The young chick lives three weeks in the shell before it sees the light of day. If we study an egg that has not been incubated, opening the shell carefully on the upper side, we find upon the surface of the yolk a little circle somewhat smaller than the end of a lead pencil. This circle is the germ. The germ of an egg in this condition is nothing more or less than the young chick asleep. The warmth of the maternal body or of the incubator is all that is necessary to awake this sleeping organism and start its life processes. As soon as it wakes up and begins its development, it builds its body step by step, using the materials provided for this building by the maternal organism. These materials consist of proteins, fats, and salts. From the egg albumen, the egg oil and the egg salts the body of the chick is developed to the condition with which we are all familiar as it leaves the shell when it is hatched. Such a chick possesses all the kinds of tissue which it will ever possess. It has a bony skeleton; it has muscles, glands, and nervous system; it has connective tissue and rudimentary feathers. It possesses special sense organs, and all of these organs and tissues are able to perform their normal functions. The process of growth and repair and of active work have already been thoroughly established, yet the bird has to the date of its hatching received no other food than that contained within the egg at the time incubation began.

C. FOOD FOR YOUNG MAMMALS

Mammals develop their young within the body of the maternal organism. Young mammals, like young birds, begin their development in an egg, but the mammalian egg is too minute to afford nourishment beyond the first few hours of development. Between that time and the birth of the young the nourishment is derived from the blood of the maternal organism, and consists of proteins, sugars, and salts absorbed from the walls of the uterus by the growing young. After the birth of a young mammal there is a wonderful provision for its nourishment that deserves more than passing attention. Nature provides for young mammals a wonderful food called *milk.* This is produced by lactiferous or milk-producing glands on the ventral surface of the mother's body. Within a few hours after the birth of a young mammal, it begins to draw milk from these glands into its stomach, where it is digested and assimilated, and built up into muscle, gland, nerve, bone, etc.

Milk on chemical analysis is shown to consist of proteins, sugar, fat, salts, and water. From these substances all the tissues of the growing animal are constructed; all repairs are made, and fuel is furnished for the body movements and for heat.

D. CHARACTERISTICS OF NATURAL FOODS

Reviewing briefly the food used by young plants, birds, and mammals, we find: Plants living upon proteins, starch, sugar, fat, and salts. Birds living upon proteins, fat, and salts. Mammals living upon proteins, sugar, fat, and salts.

All possess proteins, all possess salts, all possess either fat or sugar or starch, or a combination of these. Starch, sugar, and fat are the fuel foods. Proteins and salt are the growth and repair foods.

So we see that all of these living organisms are provided by nature with material for growth and repair on the one hand, and materials for fuel on the other. Whether this fuel consists of

sugar, or of fat, or of starch, or a combination of all, seems to be a matter that is adjusted according to the conditions of life of the individual organism. The organisms which have been chosen as examples represent the whole realm of living nature, so that the principles derived from the study of these organisms represent the fundamental principles of life.

CHAPTER III

FOODS DEFINED AND CLASSIFIED

A. WHAT IS A FOOD?

A FOOD is any substance which will supply the material needs of the body. These material needs, as shown above, are in two directions: First, constructive, and second, energy-producing. The constructive need of the body is the need for material for growth or repair, while the energy need is supplied by the fuel foods, whose oxidation furnishes the heat which maintains body temperature, and the energy—motor, glandular, or nervous—peculiar to the active tissues of the body.

A food, then, is any substance which can supply any or all of these needs. A food is an article of diet; nutriment or nourishment.

Animals' foods are, as a rule, the complex substances built up by the vegetable kingdom usually for their own use. Examples of this may be cited in the cereals, which are simply seeds of the cultivated grasses; the legumes, which are seeds of cultivated members of the leguminosæ; nuts, which are the seeds of certain trees and shrubs. All these seed foods were prepared for the nourishment of the young plants, as described above, but are gathered by the animals and used by them extensively the world over. Some animals—the herbivorous ones—crop or browse the green herbage of plants, thus living upon plant tissues direct, while other animals—the carnivorous ones—are cannibalistic in their tastes and kill other animals, consuming them for food.

These carnivorous animals, while subsisting directly upon animal tissues, get their nourishment indirectly from the vegetable kingdom, because they uniformly subsist upon herbivorous animals.

B. CLASSIFICATION OF FOODSTUFFS

The word foodstuffs (food materials) is a technical term applied to those substances or chemical combinations which are used by animals for food. Starch is a foodstuff. So also are sugar, fat, protein, and certain mineral salts. These substances are, as a rule, taken in combinations. For example, bread is a combination of all of these foodstuffs; perhaps for that reason it has been called the staff of life, because it can support the needs of the material body. Certain foods contain only one foodstuff, as is the case with cane sugar, cornstarch, olive oil, egg albumen.

In classifying food material, we are fortunate in being able to choose a basis of classification which is in harmony not only with the chemistry of these foodstuffs, but also with their use in the body. For example, proteins are used for growth and repair; they are the constructive foods. They differ from all the other foodstuffs in containing nitrogen, sulphur, and phosphates. The nitrogen is so important that the proteins have been called the nitrogenous foodstuffs. The fats, starches, and sugars contain no nitrogen, sulphur, or phosphates, but are especially rich in carbon. They have therefore been called the carbonaceous foodstuffs. The carbonaceous foodstuffs are the energy-producing foodstuffs or the fuels.

Another need of the body is supplied by water and mineral salts, but water and mineral salts are inorganic substances in contradistinction to the nitrogenous and carbonaceous foodstuffs, which are organic substances.

- FOODSTUFFS
  - Inorganic
    - Water.
    - Salts: $NaCl$, $CaHPO_4$, etc.
  - Organic
    - Carbonaceous
      - Sugars
        - Glucose,
        - Cane Sugar,
        - Syrups,
        - Honey.
      - Starches
        - Cornstarch,
        - Sago, Tapioca.
      - Fats
        - Lard, Olive Oil,
        - Butter.
    - Nitrogenous: Proteins
      - Egg Albumen,
      - Gluten,
      - Lean Meat.

C. CLASSIFICATION OF FOODS

As stated above, foods are articles of diet as found in the market. Foods are usually mixtures of foodstuffs. Bread, for example, represents all the foodstuffs. Milk is a food which contains sugar, fat, protein, salts, and water. The vegetables of the market usually represent mixtures of sugar or starch, or both, with a cellulose pulp. The fruits in a similar way are mixtures of sugar solutions with vegetable acids and salts, the whole contained in a cellulose pulp. The most convenient classification of foods is one which is based upon the chemical composition and the dietetic use of the several foods. Several such classifications have been suggested by different writers. The following classification has been used for several years by the writer in preference to others, because of its ready adaptability to the uses of practical dietetics:

Group I. Inorganic Foods: Water and salts.

Group II. Organic Foods:

Division A. Carbonaceous Foods:

Class 1. Sugars.
" 2. Starches.
" 3. Roots and tubers.
" 4. Green vegetables.
" 5. Fruits.
" 6. Fats.

Division B. Nitrogenous Foods:

Class 1. Lean meat.
" 2. Eggs.

Division C. Carbo-nitrogenous Foods:

Class 1. Cereals.
" 2. Legumes.
" 3. Nuts.
" 4. Milk.

At this point in the discussion of foods a most valuable help to the reader would be afforded by a series of chemical tests in which the experimenter could demonstrate for himself many of

the statements made here. If the student has already had laboratory work in physiological chemistry, he will be familiar with many of the facts here stated. If he has not had such a course in chemistry, he will certainly be repaid for a few weeks at a well-equipped chemical desk, verifying for himself many of the statements here made.

GROUP I. INORGANIC FOODS

Of the inorganic foods *water* may well take precedence in our discussion, because it comprises about sixty-six and two thirds per cent of the body. So much of the body is composed of water that it has been stated that we are still aquatic animals. Water is absolutely essential in the performance of every body function. One may do without the organic foods for many days or even weeks, but twenty-four hours without water will cause the victim to experience a thirst which soon becomes not only a desire, but passes beyond the stage of desire to a torturing longing for water, and this after two or three days merges into a suffering which nearly unseats the reason.

Water is used in the digestion of foods. While the water of digestion is frequently taken as drink during meals, it ought to be largely secreted by the salivary glands during the process of chewing; in order that these glands may secrete freely during mastication, one should drink copiously an hour or so before each meal.

Water is used also in the process of absorption of digested foods. Water makes up nearly ninety per cent of the circulating fluids of the body, thus making possible the easy distribution of food materials from the point where they are absorbed to the various parts of the body where they are assimilated by the tissues. Within each living cell of the body water is necessary to all the life processes. It is used by the glands in their elaboration of various products or secretions. For example, ninety-nine and one half per cent of the saliva and the gastric juice and about ninety-eight per cent of the pancreatic juice is water.

Man has in his ingenuity added many things to water, but, as a rule, these additions are useless, if not actually harmful. No

drink ever devised by man has been more effective for the slaking of thirst than pure water.

It is hardly necessary to enumerate the sources of pure water. Springs and wells furnish a large proportion of the water in general use for domestic and dietetic purposes. Cities frequently take their water from rivers and lakes, adopting many devices to protect the original source from contamination through drainage from factories, houses, and barns, as well as to protect it from contamination during its passage through reservoirs and mains. Most of the water from the sources above mentioned contains a certain amount of mineral salts in solution, for the most part carbonates. When these mineral salts are sufficient in amount to cause any appreciable curdling of soapsuds, the water is said to be hard, while waters with too small an amount of mineral substance to cause any appreciable curdling of soap are called soft waters. Springs which issue from sand usually produce soft water. Wells which draw their water from between rock strata usually produce hard water, the water having taken up salts from the rock through which it has percolated. Rain water, being really distilled water, is soft when it first falls, though it may take up various salts and other impurities from the roofs and cisterns. These impurities may be in part removed through filtration.

The boiling of water not only kills all bacterial germs, but deposits a considerable portion of the carbonates from hard water. Almost any water not actually contaminated by putrefying animal matter can be made wholesome and satisfying by boiling and aërating. Boiled water that has not been aërated has an insipid taste, but if boiled water is cooled in a jar or bottle that has been filled to only one half or two thirds of its capacity, it may be aërated by thoroughly shaking the bottle or jar. This gives the water its original flavor.

The average person needs about two quarts of water in twenty-four hours. About half of this is taken with soups, fruits, vegetables, milk, and other foods, thus leaving, as a rule, only about one quart to take as beverage. This general average need of the body is greatly varied by weather conditions. On a hot, dry day one will drink very much more water than on a cool, damp day.

This requirement of the system is quite accurately indicated by the sense of thirst. This sense can be relied upon as a faithful guide to the individual as to the amount of water needed by the system. However, this sense, like all others, is subject to perversion. Many people accustom themselves gradually to the use of a very small amount of water, less than their systems really need. As a rule, most people use too little water. Such people are almost certain to suffer from constipation and various other disturbances, which they seldom attribute to their meager use of water. One of the most important rules in personal hygiene has to do with the use of water and is as follows: *Arise at least three fourths of an hour before breakfast, drink two glasses of cold water; take ten minutes of brisk exercise in the open air, preferably out of doors. If not out of doors, then before an open window, filling the lungs full of fresh morning air, and repeatedly contracting and relaxing the muscles of the legs, arms, and trunk, particularly the latter.*

One of the most important parts played in this morning exercise is performed by the water, which washes out the stomach, carrying its slimy accumulations down through the coils of the intestine, during the morning exercise, thus preparing, as well as inducing, a copious natural evacuation of bowels, usually before eight o'clock. No more important hygienic régime could be adopted than that outlined above to produce tonicity of the muscles, keen appetite, quick and complete digestion, complete and natural excretion of waste materials, a clear complexion, and clear lustrous eyes.

This is the régime followed by those world-renowned beauties who look thirty-five at the age of seventy, as well as by those husky octogenarians who swing an ax, a scythe, or a golf club with the vim and spirit of youth, notwithstanding the fact that they have passed the age that marks the senile decay of most men.

If a person is unable to take active exercise because of invalidism, the use of the water, and perhaps massage on the part of nurse or attendant, serves a most important substitute for the above outlined strenuous régime.

Inorganic salts may be discussed very briefly because the dietitian seldom has to provide for them separately. These sub-

stances are very important, the calcium salts making the substance of bones and teeth, while the sodium, potassium, and magnesium salts are used in the circulating fluids. However, the milk which forms the first food taken by all mammals, and the egg which is the food for young birds, contain all of these salts in the proper proportions and quantities. It therefore follows that when milk and eggs are used in the diet of older animals they furnish important sources of mineral salts. All vegetable and fruit juices likewise are rich in various salts. So are also the cereals, legumes, and nuts. It would, therefore, be impossible to devise a reasonable diet which would be free from mineral salts. The usual admixture of milk, eggs, vegetables, and fruits will in a vast majority of cases contain the proper salts in quantities sufficient to serve all the purposes of the body. Common table salt seems to be an exception to the general rule, so that a diet composed largely of vegetable products needs a small addition of sodium chlorid to bring up these elements to the full requirements of the body. Herbivorous animals seem to experience the same need, and they occasionally make long journeys to find salt. Stock raisers usually put salt where it is accessible to the animals. Salt has thus come to be used as a condiment, and in this capacity it is likely to be used in quantities much greater than necessary, and while any moderate use of it cannot be looked upon as deleterious, its immoderate use is certainly not to be recommended.

About the only inorganic substance to which the dietitian needs to give special attention is *iron*. This substance is essential in the making of red blood corpuscles. It sometimes happens that more iron is excreted from the body than is taken up from the foods. This condition is due to some disturbance of nutrition. This disturbance may be in the digestion, the absorption, or the assimilation, but wherever the disturbance is, the blood-making organs do not receive the necessary amount of iron, and as a result the formation of the red blood corpuscles is interfered with. The blood becomes poor in hemoglobin; the victim becomes pale. This pallor may become extreme, until it reaches a waxy whiteness. Naturally this condition can only be removed by correcting the nutrition when that is possible. While the details of this treatment are left to the physician, to the dietitian is fre-

quently left the choice of foods. The yolk of egg is especially rich in iron. The reason for this must be evident. The iron in the egg yolk supplies that substance to the red blood corpuscles of the young chick. It seems, therefore, a rational practice in dietetics to seek this same source of supply when we wish to get iron to replenish the blood of any individual. In the use of eggs, therefore, for such patients, the yolks of two eggs might well be substituted for the yolk and white of one egg. A very good way to administer these egg yolks would be in the form of egg lemonade, using two egg yolks and the juice of half a lemon, with sugar to taste, water half a pint and iced.

Another important source of iron is to be found in lean meat, especially the highly colored, deep red meat of the better cuts of steak or mutton and the breast of wild game. A third important source of iron is to be found in the chlorophyll or green pigment of plants. This is usually served in a menu in the form of greens, as spinach, chard, etc. Lettuce, celery, and cabbage leaves have also a considerable amount of iron, but all of these vegetables are usually bleached out, and therefore have a smaller chlorophyll content, and with that a smaller amount of iron. It is better, therefore, to use the greens that have the deepest color. It is interesting to note in passing that the highly colored meat red as well as the highly colored plant green owes this color to a pigment rich in iron. The dietitian seeks this pigment to bring back to the cheek of his patient the ruddy flush of health which is also indicative of red blood rich in iron.

GROUP II. ORGANIC FOODS

This group of foods comprises a great number of highly complex substances, usually of vegetable sources, but whether directly from vegetables or from animals, they all owe their complex composition to plant life, for, as shown above, all organic animal foods come either directly or indirectly from the vegetable kingdom. These complex vegetable substances are built up step by step from simple mineral substances through the use of the sun's energy by the green pigment of plants. This process has been technically called photosynthesis. In this process of photosynthesis the

energy of the sun's light and heat becomes latent, or in some mysterious way so linked with the matter that is being constructed that it is not apparent—that is, it is not active—so we call it latent. If one pumps a tank full of water to the top of a high building, that water, because of its elevated position, is capable not only of distribution to all parts of the building having a lower level than that of the tank, but it might incidentally run water motors, thus accomplishing a great deal of mechanical work. If all of the energy liberated by this water as it flows back to the level of the pump were summed up, it would equal the amount of energy required to lift it to the elevated position. In a similar way, the building up of complex substances by the plants lifts them into an elevated position in which the energy remains latent until it is later released. When an animal takes organic food into its system, the purpose is for the most part to procure the energy latent in that food. When the food is oxidized, the energy is released in the form of heat, muscular movement, gland activity, and nervous activity. In a similar way, the use of fuel in an engine releases on oxidation the heat which sets in motion the mechanical parts.

Division A. Carbonaceous Foods.—This term is used to include all those foods whose principal constituent is carbon. The carbonaceous foods are the fuel foods. All of these foods are composed of carbon, hydrogen, and oxygen. The sugars and starches are usually grouped together and called carbohydrates. The reason for this grouping is shown in the fact that hydrogen and oxygen of sugars and starches always exist in the proportion of two atoms of hydrogen for one atom of oxygen, that is, in the proportion to form water. Whenever the molecule is oxidized the amount of oxygen required to oxidize any carbohydrate molecule is therefore the amount required to oxidize the carbon of that molecule. The grape sugar or dextrose molecule has the formula $C_6H_{12}O_6$. Two atoms of oxygen are required to oxidize each atom of carbon, therefore one molecule of dextrose or grape sugar requires twelve atoms of oxygen to oxidize it. Such oxidation releases six molecules of carbon-dioxid gas. A molecule of cane sugar ($C_{12}H_{22}O_{11}$) requires twenty-four atoms of oxygen for its oxidation, and releases twelve molecules of CO_2 and eleven

molecules of water. In a similar way the oxidation of starch requires two atoms of oxygen for each atom of carbon, and releases five molecules of water for every six molecules of carbon-dioxid gas, the formula for starch being $C_6H_{10}O_5$, taken *n* times, or $(C_6H_{10}O_5)_n$.

The fats form another group of carbonaceous foods, and differ radically from the carbohydrates in the grouping of the carbon, hydrogen and oxygen atoms within the molecules. The common food fats are usually mixtures of palmitin, stearin, and olein, olein being a liquid at all usual temperatures, the other two being solid at all usual temperatures. Olive oil is nearly pure olein; beef tallow has a large proportion of stearin. The quantitative chemical formulas for these fats are as follows:

Palmitin	$C_3H_5(C_{16}H_{31}O_2)_3$
Stearin	$C_3H_5(C_{18}H_{35}O_2)_3$
Olein	$C_3H_5(C_{18}H_{33}O_2)_3$

Note from these formulas that the hydrogen and oxygen do not exist in the proportion to form water, there being only a very small amount of oxygen in each molecule, so that after the carbon is oxidized there still remains a large amount of hydrogen to be oxidized. The oxidation of this hydrogen yields a great deal of heat. It must then be evident that an ounce of fat will yield far more energy when oxidized than an ounce of sugar or of starch. As a matter of fact, it yields about two and a half times as much.

It is not to be understood that the carbonaceous foods to be here enumerated contain only sugar, starches, and fats, but many of these foods, particularly the vegetables and fruits, contain admixtures of proteins, as well as of salts and water. However, these admixtures of protein, salts, and water are negligible in quantity. The classification, then, depends on the principal organic foodstuff present, which in every case is carbonaceous.

CLASS 1. SUGARS.—The sugars important to the dietitian are glucose, cane or beet sugar, and maple sugar. Glucose is manufactured from corn by a conversion of the starch to sugar. This sugar made from corn differs from cane sugar in its simpler chemical composition, its formula being $C_6H_{12}O_6$. While glucose is

wholesome and cheap, it has not gained popular favor to any great extent, because it has a noticeably less sweetening power than cane sugar; because of its cheapness it has been extensively used in cheaper grades of candy and cheaper table syrups, and sometimes resorted to as an adulterant to cane sugar, maple sugar, maple syrup, and honey. The glucose syrups are extensively used as table syrups, and while they are wholesome and cheap, they lack the pleasing flavor of maple syrup and of cane syrup.

Cane sugar or beet sugar, the common granulated sugar of the market, has two general sources, the sugar cane of the South and the sugar beet of the North. Sugar made from these materials possesses the formula $C_{12}H_{22}O_{11}$, and is known to the chemist as saccharose. The brown sugars of the market usually represent saccharose in early stages of refining. These brown sugars and syrups, made from cane and beet sap, have a distinctive and rather pleasing flavor, which is naturally lost in the processes of refining, the pure granulated sugar being practically flavorless and possessing simply sweetness.

Maple sugar and maple syrup are produced from the sap of the sugar maple and the rock maple. These sugar-producing maples are found in the Northern States from Michigan and Indiana to the Atlantic, as well as in southern Canada. The trees are tapped in the early spring when the sap begins to flow; the sap is boiled down to syrup, or to the point of granulation in sugar, in a way very similar to the making of syrup and the brown sugars from cane or beet sap. Maple sugar possesses a flavor peculiar to itself and one which is very pleasing to most people. If the brown maple sugar were subjected to the refining processes it would yield a white, flavorless sugar almost identical to cane sugar, but the loss of its pleasing flavor would be too great a price to pay for refining, so we find maple sugar always marketed in the brown cakes. Being much higher in price, there is a great temptation to adulterate the maple sugar and syrup, and it is likely that many brands on the market have been thus adulterated. As they are, however, adulterated with saccharose, glucose, or a mixture of the two, the product is both wholesome and sweet, though it is likely to possess the distinctive flavor in a smaller degree because of the adulteration.

Sugars are easily soluble in water and require very little digestion to be ready for absorption. The glucose requires no digestion at all, and is ready for absorption as soon as it is dissolved in the saliva. The saccharose, however, requires to be split up or converted into its two component monosaccharid molecules (dextrose and levulose). This splitting of the saccharose into dextrose and levulose takes place in the small intestine, and is brought about by the influence of the ferment called invertin.

While the sugars above mentioned are the only ones to which the dietitians need give any thought in the preparation of menus, there are other sugars which possess some importance as nutrients, and may be mentioned here. Milk sugar has already been mentioned as one of the constituents of milk. The sugar of milk is called lactose. This sugar is closely related to saccharose, having the formula $C_{12}H_{22}O_{11}$. Like saccharose, it is a disaccharid, and requires to be split up into its monosaccharid molecules before it is absorbed. This splitting takes place in the small intestine under the influence of a ferment called lactose. The two monosaccharid sugars into which it is split are called dextrose and galactose.

Many of the vegetables and most of the fruits have sugar in smaller or larger quantities. The sweet potato, for example, owes its sweet taste to sugar, as is also the case with the beet, the carrot, the parsnip, the turnip, among vegetables; while among the fruits, the sweet taste, wherever found, is due to the presence of sugar. Grapes possess large quantities of sugar, so also do plums, cherries, figs, and dates. Most fruits possess sugar as practically their sole nutrient, the other parts of the fruit being simply a cellulose pulp, water and mineral salts in solution, together with a flavor peculiar to each particular fruit. The sugar of fruits and vegetables is in most cases a reducing sugar, usually either dextrose ($C_6H_{12}O_6$) or fructose ($C_6H_{12}O_6$).

Sugars are the most easily assimilated fuel foods, and are capable of oxidation within a few minutes after they have been taken into the stomach. For this reason they have been used by athletes, by mountain climbers, and soldiers in their feats of strength and their forced marches, because a few lumps of sugar taken with two glasses of water will begin to yield energy in the

form of heat and muscular strength within, at most, thirty minutes after they have been taken. While sugars may be thus used in emergencies, they possess two rather positive disadvantages—namely, the tendency to surfeit the appetite, so that one after a short time would take his ration at first without relish, then later with positive disgust. Another disadvantage with sugar as a ration is the readiness with which it can be thrown into a state of fermentation in the stomach. As we shall learn in a subsequent chapter, the presence of sugar in the stomach is not followed by a secretion of the gastric juice. Whenever the quantity of gastric juice is below the normal during the period of digestion, the chance for fermentation is greatly increased, as the acid of the gastric juice tends to stop sugar fermentation.

Notwithstanding these two disadvantages of sugar as a special ration, we can hardly emphasize too strongly the great advantage of sugar as a moderate and reasonable part of a regular mixed diet. The greater the muscular activity of the individual, and the lower the temperature to which he is subjected, the greater the need for this particular foodstuff. Men who are doing heavy work out of doors in the winter time can take prodigious quantities of sugar, syrup, and molasses with only favorable results. As a rule, men working under such conditions crave sweets, and their craving may be taken as a natural indication that they need sweets.

Class 2. Starches.—The most important carbonaceous food which we use is starch. Most of our starch comes from potatoes and the cereals, such as corn and wheat. Under this head we will discuss, however, those starch foods found in the market as practically pure starch. These starch foods in the order of their importance in the dietary are: Cornstarch, tapioca, sago, arrowroot. Cornstarch is prepared from young maturing corn. In the process of manufacture the proteins and oils and cellulose are completely separated from the starch, and this is collected in a practically pure state, and marketed as a white powder of almost impalpable fineness. Tapioca is derived from the root of a tropical plant, while sago is from the pith of the sago palm. These products are practically pure starch, and are found in the market in granular form. Arrowroot is a similar product, though less extensively used than any of the above. In preparation of these

products they absorb a great deal of water and in cooking swell up into a paste or jelly, opalescent, clear, or milky colored. While they represent more or less condensed nourishment, as is the case with sugar, they are quite flavorless and require the admixture of other substances to give them relish. It is very common to mix fruit of some kind with tapioca and sago, and to make a fruit dressing or a cream dressing rather highly flavored with vanilla or lemon to be taken with the various cornstarch preparations.

While these cornstarch preparations are, as a rule, used as desserts, there is no good reason why they might not be used as a principal source of starchy foods. The custom, however, of flavoring them with the fruit or cream dressings and admixtures has, without doubt, determined their location in the menu among the desserts.

The starches are chemically closely allied to the sugars, and in their digestion the complex starch molecules composed of many monosaccharid groups are step by step broken up, first into dextrin, then into maltose, and finally into dextrose. This process begins in the mouth, where the ptyalin of the saliva changes the starch into dextrin and maltose. The maltose, which is a disaccharid ($C_{12}H_{22}O_{11}$), passes unchanged through the stomach into the small intestine, where the ferment maltose breaks it up into two dextrose molecules. In this form it is absorbed and used in the body for the production of heat and muscular energy in a way exactly as are the monosaccharid molecules derived from the sugar direct.

Class 3. Roots and Tubers.—This class of foods represents a division of the vegetables, while the class green vegetables represents another portion. The division into these two classes, roots and tubers and green vegetables, is a practical one from a dietetic standpoint, and is justified by the fact that the roots and tubers are less perishable, and are in the market practically the year round, while the green vegetables are, like the fruits, very perishable, and are marketed " in season " like many of the fruits.

While it is true that the great metropolitan markets carry radishes and green onions, spinach, lettuce, and various other perishable vegetables, these foods are brought from the far South in February, from the Middle States in midsummer, and from North-

ern gardens in the early autumn, while the greenhouses produce the same things in midwinter, so that some of these garden products can be procured every month in the year. In rural districts and those towns and cities not in daily communication with the various trade centers these perishable vegetables are procurable "in season" only, the "season" of any particular section being the time of the year when the vegetable or fruit in question is marketable in that section.

Table I.—Roots and Tubers

Food Materials.	Water. Per Cent.	Protein. Per Cent.	Fat. Per Cent.	Carbo-hydrates. Per Cent.	Ash. Per Cent.	Food Value per Pound. Calories.
Potatoes (white)........	75.0	2.1	0.2	22.0	0.7	295
Sweet Potatoes.........	69.4	1.5	0.3	26.2	2.6	440
Beets..................	87.0	1.4	0.1	7.3	0.7	160
Parsnips...............	64.4	1.3	0.4	10.8	1.1	230
Turnips................	92.7	0.9	0.1	5.7	0.6	120
Onions.................	86.0	1.9	0.1	11.3	0.7	225

Roots and tubers, then, are vegetables in season the year round and comprise white potatoes, sweet potatoes, onions, beets, turnips, carrots, parsnips. So important an article of diet is the *potato* that there are few tables in Europe and America where this vegetable does not appear at least once in a day, while its appearance at all three meals is not at all unusual. The white potato shows on chemical analysis 75 per cent of water, 2.1 per cent protein, 0.2 per cent fat, 3.2 per cent sugar, 18.8 per cent starch, and 0.7 per cent mineral salts. From this analysis it will be seen that the carbonaceous foods make up a little over twenty-two of the twenty-five per cent of solids. So, while there is present in the potato about two per cent proteins, we classify this vegetable as a carbonaceous food. This classification is further justified from the fact that we look upon it as an important source of starch for the menu, while it is wholly ignored as a source for proteins. It may be stated in passing that the proteins of the potato exist almost wholly in the two or three layers of cells immediately underneath the thin brownish epidermis. If in the preparation of the potato it is peeled in the ordinary way, these outer

layers of cells are removed along with the skin, and thus a large part of the protein is lost. Furthermore, there is lost that substance, whatever it may be, that gives to the potato its distinctive

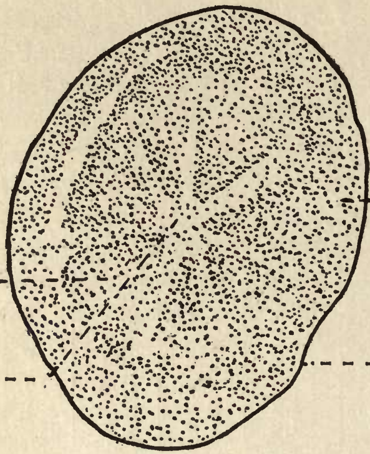

FIG. 1.—CROSS-SECTION OF A POTATO.

flavor, so that if it is peeled before being cooked it is practically flavorless. This may, however, be of no especial disadvantage, inasmuch as it is usually eaten with meat, perhaps with meat gravy, which supplies it a sufficient and pleasing flavor. If, however, one wishes to retain the natural flavor of the potato, as well as the highly nourishing protein, he should cook the potato without removing the skin. If the potato is boiled with its jacket on this may be quickly and easily removed before serving. If it is baked with the jacket on, the jacket may be eaten.

The *sweet potato* is so called because the amount of sugar present is sufficient to give it a distinctly sweet taste. The chemical analysis (water, 69.4 per cent; protein, 1.5 per cent; fats, 0.3 per cent; sugar, 10.2 per cent; starch, 16 per cent; salts, 2.6 per cent) shows the sweet potato to have a larger amount of nourishment in a given weight than the white potato, and a relatively smaller amount of water. They are so nearly like the white potato, however, in their dietetic value that one should observe the general rule of serving only one of these vegetables in a menu—that is, if

one has sweet potatoes, he should not also have white potatoes. In other words, the sweet potato should never be taken as a second vegetable combined with white potato. But when we have either of these, we should add to the dinner menu a side dish of some other vegetable, as onions, beets, turnips, cabbage, cauliflower, spinach, asparagus.

Onions show on chemical analysis: Water, 86 per cent; proteins, 1.9 per cent; fats, 0.1 per cent; sugar, 2.8 per cent; salts, 0.7 per cent; extractives, 8 per cent—only 14 per cent of solids, of which only about 4 per cent represent nourishment, while the remaining 10 per cent is made up of cellulose, mineral salts, and "extractives." It is evident that the onion is not eaten for the sugar, nor for the trace of protein which it contains. Among the so-called "extractives" there is a volatile oil which gives the onion its individual flavor. This flavoring material possesses the unique quality of imparting its character, more or less modified and refined when used judiciously, to foods with which it is mixed. The use of smaller or larger quantities of onions has come to be almost universal throughout Europe and America as a food adjunct or flavoring material. The tender young onion from the garden is eaten direct, and serves as a pleasing relish in the warm days of the later spring and early summer, when the whole world turns to the out of doors to get something green and fresh and appetizing. Sliced onion makes an important addition to several of the vegetable salads. Boiled onions served with melted butter or cream sauce make a delicious side dish of vegetables, appropriate any time between October 1st and the following spring.

In the preparation of onions in the kitchen, if the volatile oil annoys one by causing the eyes to water, this annoyance may be avoided by peeling and cutting the onions under water, the water over the onion stopping the escape of the volatile material.

Beets (water, 87 per cent; proteins, 1.4 per cent; fat, 0.1 per cent; sugar, 7.3 per cent; ash, 0.7 per cent; extractives and cellulose, 3.5 per cent). These vegetables possess considerable nutritive power, the nutrient being saccharose. Beets are eaten quite extensively in midsummer as greens, the rich, dark leaf of the beet making greens quite as palatable as spinach or chard. Beet tops may be used in this way even up to the time when the

beet root is of sufficient size so that one can substitute the young boiled beets for the beet greens. When young beets are served boiled, it is customary to serve them with butter. As the season advances and they reach their maturity, it is customary to slice the boiled beets, put them in vinegar, serving them as beet pickles.

Carrots.—Carrots are found in the market early in the summer and throughout the autumn and winter months. Their food value consists especially in their carbohydrates, eight per cent, mostly sugar. As an article of diet during the winter the carrot is quite as important as the beet. It contains a much larger proportion of cellulose than the beet, and is therefore more difficult of digestion. However, if thoroughly cooked and sufficiently masticated, it makes a good side dish of vegetables at a dinner. In its preparation it is usually boiled, and because of its rather distinctive flavor it is frequently added to stews, braises, boiled dinners, etc. As a side dish it may be served either with cream dressing or butter.

Turnips.—The turnip contains over ninety per cent of water and about five per cent carbohydrates, mostly sugar. It is, therefore, not to be recommended as an important source of nourishment. The extractives (two per cent) give it the flavoring material which accounts for the use of the turnip in the dietary. It is found in the market from later summer to the following spring. When thoroughly cooked by boiling it makes a side dish of vegetables which is likely to excite by its strong flavor a keen relish for the dinner. The addition of such highly flavored side dishes is strongly to be recommended, particularly if they are chosen and prepared so skillfully as to have this greatly desired effect—namely, of exciting keen relish and whetting the appetite. As we shall find in our later studies, the processes of digestion proceed much more rapidly, and are accomplished much more completely, if the food is relished. We thus have ample justification for the introduction into the menus of anything which excites the appetite, even though that appetite exciter or relish stimulator may possess in itself little or no nutriment.

Young turnips when taken fresh from the garden in later summer or early autumn may be boiled and served either in cream sauce or with butter. They should be peeled before boiling, be-

cause the removal of the skin gives them a somewhat more delicate flavor and texture. During the winter it is customary in serving either the white turnips or the rutabaga, to peel, boil, and serve them mashed. Turnips, like carrots, are well adapted as adjuncts to stews, braises, and boiled dinners.

Parsnips.—The parsnip is similar to the carrot in some respects but has a smaller proportion of water and a much larger amount of sugar and starch. The parsnip appears in market usually about Thanksgiving time and may be found there any time during the winter and spring months. The reason for its late appearance in fall is due to the fact that it requires frost to develop its best flavor, some gardeners preferably leaving their parsnips in the ground until spring, contending that the cold of the winter is required to develop their finest flavor. The parsnip possesses strong individual flavor, which adapts it quite as well as the turnip and the carrot for an appetite-producing side dish. In its preparation it should be thoroughly boiled and served either with a cream sauce or with butter. A popular and pleasing way of serving parsnips is to fry them after they have been boiled, the frying apparently developing the finest flavor of the vegetable.

CLASS 4. GREEN VEGETABLES.—As explained above, this division of the vegetables includes those that are perishable and for that reason marketed in season, though the season may be greatly prolonged in the great metropolitan markets. The green vegetables comprise cabbage, cauliflower, celery, spinach, asparagus, lettuce, water cress, tomatoes, cucumbers, egg plant, rhubarb, squash, green peas and beans, and green corn. From the following table, which shows the chemical analysis of these foods, it will be seen that they possess a negligible quantity of nutrients, a large part of their substance being made up of water and pulp, the pulp mostly cellulose and extractives, the combined organic foods ranging from five per cent to three per cent or less. If the question is raised, Why do we eat such things? we must seek the answer in the fact that nearly all of these garden products possess either strong individual flavors which we have learned are distinctly appetite-producing, or they are distinctly acid; as in the case of tomatoes and rhubarb particularly. Cabbage, celery, lettuce, cress, tomatoes, cucumbers may be and frequently are eaten raw, with the addition

of some such condiments as salt, pepper, vinegar. When these vegetables can be served crisp and fresh there is no reason why they should not be thus served; the only caution to be observed is that they should be very thoroughly masticated. The chewing should be continued until they are reduced to a creamy pulp. When thus chewed these raw, green vegetables are easily disposed of by the digestive system and seldom cause any discomfort.

Table II.—Green Vegetables

	Water. Per Cent.	Nitrogenous Matter. Per Cent.	Fat. Per Cent.	Carbohydrates. Per Cent.	Mineral Matter. Per Cent.	Cellulose. Per Cent.	Fuel Value per Pound. Calories.
Cabbage	89.6	1.80	0.40	5.8	1.30	1.10	165
Spinach	90.6	2.50	0.50	3.8	1.70	0.90	120
Vegetable marrow	94.8	0.06	0.20	2.6	0.50	1.30	120
Tomatoes	91.9	1.30	0.20	5.0	0.70	1.10	105
Lettuce	94.1	1.40	0.40	2.6	1.00	0.50	105
Celery	93.4	1.40	0.10	3.3	0.90	0.90	85
Rhubarb	94.6	0.70	0.70	2.3	0.60	1.10	105
Water cress	93.1	0.70	0.50	3.7	1.30	0.10	110
Cucumbers	95.9	0.80	0.10	2.1	0.40	0.50	70
Asparagus	91.7	2.20	0.20	2.9	0.90	2.10	110
Brussels sprouts	93.7	1.50	0.10	3.4	1.30	0.37	95

The following vegetables are always served cooked: Cauliflower, spinach, asparagus, squash, green peas and beans and green corn. The regular method of cooking these is to boil them. The boiling should be carried to a point where the vegetable is made tender and easy of mastication. Cabbage, when cooked, should be prepared in a similar way. These vegetables should be served as side dishes. The cabbage, cauliflower, asparagus and squash, peas and beans, may be creamed or served with butter. Cooked tomatoes may be seasoned with pepper and salt; their acidity suggests sugar to some tastes. Celery, lettuce, and cress are used almost exclusively either uncooked as relishes or uncooked in salads. In the cooking of cabbage, it should always be put into boiling water and cooked not more than thirty minutes in an open porcelain-lined kettle. When thus cooked it retains its delicate colors and develops its finest flavor. If boiled in a closed kettle for a long period, all of this delicacy of flavor is lost and the wilted leaves turn brown.

Egg plant is usually sliced crosswise, breaded and fried.

Rhubarb is usually stewed. It is sometimes baked in a pie or tart. This vegetable is from a practical dietetic standpoint rather to be classed among the fruits than here among the vegetables because it is generally used as a fruit and in place of a fruit. The rhubarb pie takes the place of apple or cranberry pie, as rhubarb sauce or stewed rhubarb takes the place of apple sauce or cranberry sauce. Rhubarb possesses a high degree of acidity due to the large quantity of malic acid. The acidity is so great as to require almost as much sugar as rhubarb to make it palatable. However, this extreme tartness is very appetizing in the early spring when the rhubarb appears in the market. Furthermore, the juice of the rhubarb contains considerable quantities of organic salts (malates of sodium, potassium, lithium, etc.). These vegetable salts are very important in the nutrition as they increase the alkalinity of the blood, and increase the activity of the kidneys and skin. All of these effects in the functions are important ones to produce, and particularly in the spring of the year, when some of the functions of the nutritive system are likely to be somewhat sluggish. Besides these important results above mentioned, rhubarb influences the bowels, acting as a mild laxative. Altogether, then, rhubarb is a most important green vegetable and should be used freely for a number of weeks during the year.

Besides the influence common to all of these green vegetables as whetters of the appetite, we must not forget the fact that several of them produce very clearly marked therapeutic results. The laxative and diuretic effects of rhubarb have been mentioned above. Green corn also possesses a marked laxative effect. Asparagus possesses a diuretic effect by stimulating particularly the action of the glandular portions of the kidneys, while the vegetable salts of rhubarb influence particularly the secretion of water and salts by those glands. On the other hand, lettuce and celery both act as sedatives on the nervous system.

Spinach and other greens, as beet tops, dandelions, or chard, besides making a much-relished side dish, contain large quantities of a plant pigment, chlorophyll, which, as stated above, is rich in iron, and may be looked upon as an important source of iron.

Class 5. Fruits.—While fruits technically include all those plant products which bear or contain the seed, we shall include

in our dietetic class of fruits only the pulpy fruits. From a dietetic standpoint, the most practical classification of fruits is into three groups—namely, acid, bland, and sweet. We inclūde under the acid fruits those which require the addition of sugar to make them palatable. Under sweet fruits we include those that naturally contain so much sugar that no more is required to be added, either in the preservation or in their use in the menu. Under the bland fruits, which is much the longest list, are included those varieties which are neither distinctly acid nor distinctly sweet. The most typical and widely used acid fruits are the citrous group, comprising lemons, limes, grape fruit, oranges, etc. Those typical of the sweet fruits are figs and dates, while the most typical bland fruits are pears, grapes, blackberries, blueberries, melons, and bananas. This classification of fruits is valuable because it is based upon their dietetic use.

Group A. Acid Fruits.—Physiologically, acid fruits are valuable for the acids and organic salts which they contain. These are citrates, malates, or tartrates of potassium, sodium, magnesium, and calcium. In the juice of the citrous fruits, for example, we have citrates of these minerals; in apples, pears, peaches, and apricots, malic acid and malates; while in grapes tartaric acid and the tartrates predominate. When these fruit juices are taken into the digestive canal, they are readily absorbed and carried with the absorbed food to the liver, where the acids and the acid elements of the organic salts are oxidized, releasing the potassium, sodium, magnesium, etc., which are changed to carbonates at once and thus increase the alkalinity of the blood. Furthermore, these alkalies are soon eliminated by way of the kidneys. This accounts for the diuretic effect of the acid fruits.

At first thought, the idea of acid fruit juice causing the blood to become more alkaline seems paradoxical, but the fact remains and has been amply demonstrated, and when explained as above, seems most reasonable.

The acid fruits comprise the following varieties: lemons, limes, grape fruit, oranges, cranberries, gooseberries, whortleberries, pineapples, currants, and rhubarb. As explained above, under green vegetables, while rhubarb is not a fruit, it is used in the menu as such. It might be remarked in passing that while the tomato is

really a fruit, it is used in the menu as a vegetable, and we will classify it dietetically as such. The acid fruits are wholesome in a general way, because of their influence particularly on the action of the kidneys, all of them stimulating that action. The citrous fruits possess this quality in the strongest degree, and are indicated for free use whenever it is desired to produce free elimination from the kidneys and skin. Rhubarb possesses the quality also of a laxative, as set forth above. While sweet oranges may be eaten without addition of sugar, the acidity of most of the fruits of this group is so intense as to require the addition of considerable sugar to make them palatable. However, such addition does not in any way detract from the value of the acid and organic salts. All of the fruits possess pulp, seeds, and skin. The seeds and skin are usually removed in the preparation of the fruit for eating. However, in the case of strawberries, raspberries, blackberries, blueberries, bananas, figs particularly, the seeds are small and surrounded by pulp and are usually taken with the pulp. While they pass through the alimentary canal undigested, they are usually not only harmless but in most cases positively advantageous, because of the mechanical stimulus which they exert upon the peristaltic action of the walls of the intestines.

Group B. Bland Fruits.—Under this head we group a large number of fruits whose acidity is usually not so great as to require the addition of sugar to make them palatable, and yet whose sugar content is not great enough to justify their classification as sweet fruits. Naturally, there will be found in this group some fruits which present varieties sufficiently acid to justify their classification under acid fruits, and other varieties which are so sweet as to justify their classification under the sweet fruits. For example, cherries exist in acid, bland, and sweet varieties; the same with apples, plums, and strawberries; perhaps, also, with apricots and peaches. On the other hand, pears, grapes, raspberries, blackberries, blueberries, mulberries, melons, and bananas, when thoroughly ripe, are so sweet as to need no further addition to make them edible. However, even this group does not contain enough sugar to make these fruits important sources of sugar in the diet, so that we hardly eat them for nourishment, but resort to them because of their appetizing flavors.

Group C. Sweet Fruits.—Under this head we will enumerate as typical examples figs and dates, which contain so large a proportion of sugar as to make them important articles of diet in countries where they are produced. The dried figs of the market contain only twenty per cent of water and 62.8 per cent carbohydrates, mostly sugar. The 5.5 per cent protein is contained largely within the seeds, and as these are not usually broken in the mastication, this protein contained within them has little dietetic value. It is the sugar which possesses the value, the nutritional value. Dates are closely similar to figs in their chemical analysis, containing even more sugar (65.7 per cent). Dried prunes and raisins might be mentioned under this class, the former containing sixty-six per cent sugar, the latter seventy-four per cent. However, prunes and raisins as ordinarily used in the dietary are of secondary importance as sources of sugar. Figs and prunes possess a very noticeable laxative effect, due without doubt to the seeds in the case of the figs.

In the choice of fruits, one should be governed largely by the season, choosing such as are in season so far as possible. The great advantage in this is that the fruits in season are always in better condition, because they can be picked riper and are not exported so far, therefore more wholesome. One should especially avoid the choice of unripe and immature fruit, as in such the proportion of cellulose and tannic acid is far greater than in ripe fruits. When one cuts an immature apple, for example, with a steel knife, the presence of tannin is shown in the dark stain (tannate of iron) which is shown on the knife blade and in the brown color which the cut surface shows within a very few minutes after it is exposed to the air. Thoroughly ripe fruit gives these indications in only a slight degree and after much longer time, due to the fact that during the last days of the ripening process cellulose and tannic acid are changed to sugar and fruit juices. It is easy to understand how the ingestion of several green apples can cause a severe case of indigestion in the case of the small boy who cannot wait for the autumn sun to finish its ripening process.

Another thing to avoid in the choice of fruits is over-ripeness or beginning decay. Properly speaking, a fruit cannot be too ripe. However, if completely ripe when gathered, it is usually

so mellow that if it has to undergo delays of hours or even days in transportation from the garden or orchard to the table, and is subjected to high temperature, dust and jolting in transit, it may be reduced to an unrecognizable mass of fermenting pulp by the time it reaches its destination. Fruit growers are compelled, therefore, to gather fruits that are to be transported long distances before they are completely ripe, thus necessitating a part of the maturing process to be accomplished in transit. This enables the dealers to deliver at the door of the consumer fruit which is presentable and not unwholesome. Such fruits, however, should be very carefully looked over before they are brought to the table to discard any portions that have been injured in transit or that show signs of fermentation or decay.

Table III.—Fruits

	Water. Per Cent.	Proteid. Per Cent.	Ether Extract. Per Cent.	Carbohydrates. Per Cent.	Ash. Per Cent.	Cellulose. Per Cent.	Acids. Per Cent.
ACID:							
Apples..........	82.50	0.40	0.5	12.5	0.4	2.7	1.0
Apricots........	85.00	1.10	0.6	12.4	0.5	3.1	1.0
Peaches.........	88.80	0.50	0.2	5.8	0.6	3.4	0.7
Plums..........	78.40	1.00	0.2	14.8	0.5	4.3	1.0
Cherries........	84.00	0.80	0.8	10.0	0.6	3.8	1.0
Gooseberries	86.00	0.40	0.8	8.9	0.5	2.7	1.5
Currants........	85.20	0.40	0.8	7.9	0.5	4.6	1.4
Strawberries	89.10	1.00	0.5	6.3	0.7	2.2	1.0
Whortleberries ..	76.30	0.70	3.0	5.8	0.4	12.2	1.6
Cranberries	86.50	0.50	0.7	3.9	0.2	6.2	2.2
Oranges........	86.70	0.90	0.6	8.7	0.6	1.5	1.8
Lemons.........	89.3	1.00	0.9	8.3	0.5	1.5	1.8
Pineapples......	89.3	0.04	0.3	9.7	0.3	1.5	7.0
BLAND:							
Pears...........	83.90	0.40	0.6	11.5	0.4	3.1	0.1
Blackberries	88.90	0.90	2.1	2.3	0.6	5.2	1.6
Raspberries.....	84.40	1.00	2.1	5.2	0.6	7.4	1.4
Mulberries......	84.70	0.30	0.7	11.4	0.6	0.9	1.8
Grapes.........	79.00	1.00	1.0	15.5	0.5	2.5	0.5
Watermelons....	92.90	0.30	0.1	6.5	0.2	1.0	0.5
Bananas........	74.00	1.50	0.7	22.9	0.9	0.2	0.5
SWEET:							
Dates, dried.....	2.08	4.40	2.1	65.7	1.5	5.5	7.0
Figs, dried......	2.00	5.50	0.9	62.8	2.3	7.3	1.2
Prunes, dried....	2.64	2.40	0.8	66.2	1.5	7.3	2.7
Raisins.........	10.60	2.50	4.7	74.7	3.1	1.7	2.7

As a rule, fruits which are luscious and sweet when gathered thoroughly ripe, are tart and much less palatable and highly flavored when gathered immature to be cured in transit. In many cases these fruits require stewing and the addition of considerable sugar to make them wholesome and palatable. Among the fruits thus frequently prepared may be named currants, gooseberries, apples, cherries, raspberries, blackberries, whortleberries, plums, apricots. Among the fruits uniformly prepared in this way are cranberries, while among fruits uniformly served fresh or uncooked are grape fruit, oranges, strawberries, grapes, melons. Bananas, though usually served uncooked, are sometimes baked in the oven.

If the banana is not thoroughly ripe it is probably more wholesome when baked, as the cooking makes the starch digestible. It is the presence of starch in the pulp of the banana that makes it so unpalatable when not ripe. The ripening process changes the starch to sugar.

Class 6. Fats.—While the fats are carbonaceous foods, the nutrient material of fats is quite different from that of starches and sugars, as explained above. The fats contain a large proportion of carbon and a proportion of oxygen far too small to oxidize the hydrogen of the compound. For that reason, as explained above, the oxidation of fats yields a far larger quantity of heat than does the oxidation of the same weight of sugar or starch.

Fats are comparatively easily assimilated. They are digested in the small intestine so they pass through the mouth and stomach with no digestive change. However, to facilitate their ready passage out of the stomach, all fatty tissues such as fat meat should be very thoroughly masticated. Within the stomach these fatty tissues are broken up by the digestion of the connective tissue, thus releasing the fat globules which become more or less emulsified within the stomach contents and pass through the small intestine, where they are subjected to the action of the mild but copious carbonates of the intestinal juices, and to the ferment action of lipase (steapsin). The combined action of these digestive agents changes the fat into an emulsion and eventually saponifies it, thus releasing the glycerin of the fat molecule and reducing the fat to soluble components, soap and glycerin.

Thus dissolved, the products are absorbed, changed back into fat and carried by the circulation out to the working tissues, where they are assimilated and for the most part used by the tissues as sources of energy. However, a portion may be deposited in the body in the form of fat, and held in reserve for future use.

The chemical subdivision of fats into palmitin, stearin, and olein, as given above, has little dietetic value; a more practical classification would be into animal and vegetable fats. *The animal fats* comprise *butter,* which is practically pure milk fat; and *cream,* which contains a considerable admixture of protein, and of sugar, analysis being water 66 per cent, protein 2.7 per cent, sugar 2.8 per cent, salts 1.8 per cent, and fat 26.7 per cent. While there is considerable uniformity in the composition of butter, being ninety-eight per cent fat, there is considerable variation in the combination of cream, the variation arising from the quality of the milk, and the method of gathering. If rich Jersey milk is chilled as soon as drawn and allowed to stand twenty-four hours in open crocks, the cream which rises has almost the consistence of butter, and it may be cut with a spoon or spread with a knife; but cream which is separated from milk of only moderate richness by a centrifugal separator has only slightly greater consistency than the whole milk produced by a Jersey cow. It is, however, deeper in color and conforms approximately to the above analysis in composition.

Meat Fat.—The fat of beef, mutton, and pork is an important source of diet fat. As a rule, the fat is so closely associated with the lean that it is taken more or less incidentally along with the proteins of the lean meat. However, its quantity can be in a general way determined by inspection and more accurately determined by actual separation of the fat and weighing it. Meat fats should be very thoroughly cooked in the presence of moisture, if they are to be easily digestible. This is readily accomplished in the usual method of cooking meats in which there is a large admixture of fat. When thoroughly cooked the connective tissue of the fat is readily digestible and is thoroughly broken up in the stomach, thus releasing the fat in the globules. When fat is thus thoroughly cooked it is very easy of mastication and digestion. Uncooked or rare fat is much more difficult both of mastication

and of digestion. Certain meat fats, particularly side pork and bacon, as usually found in the market, possess so small a proportion of protein that that foodstuff can be practically ignored and such meats classified not among the protein foods, but among the fats.

The usual method of preparing bacon is to fry it in a pan, or bake it in the oven in thin slices. In either case it should be done brown but not cooked to the point of frying out most of the fat and making it brittle. When thus prepared and thoroughly masticated along with bread or potatoes, bacon becomes a most wholesome and easily assimilated source of fat.

Cod liver oil, as the name suggests, is derived from the liver of the cod and differs from the common food fats in possessing an admixture of bile salts and certain other materials which give it an odor and flavor not pleasing to most people. However, this fat is more easily absorbed and assimilated than any of the other fats. It has, therefore, been resorted to very extensively as a nutrient in cases of wasting diseases and malnutrition, as in tuberculosis, etc.

The pure oil is perhaps better to adminster than any of the numerous emulsions exploited. If unpalatable, it may be made less so by adding to it a few drops of lemon juice, a pinch of salt, some strong coffee, or some maple syrup. It is often given in flexible capsules.

Vegetable Fats.—The most common of the vegetable fats is olive oil, which is derived from ripe olives by reducing them to a pulp from which the oil is pressed out. Olive oil is nearly pure olein, and because of the sweet taste which it possesses when very fresh, has been called "sweet oil." It is a most wholesome form of fat and is used very largely in salads and salad dressings. It may be substituted for cod liver oil whenever the latter is indicated. Cottonseed oil, derived, as the name would suggest, from cotton seed, does not possess the sweet taste typical of fresh pure olive oil. It is, however, largely used as a substitute for olive oil, and when perfectly fresh is not objectionable.

Nut oil, for example peanut oil, is derived from the nuts by pressure. These oils are wholesome and may be substituted for olive oil in the dietary. They are not, however, in general use.

Division B. Nitrogenous Foods.—As explained above, the animal body has two general needs: first, for building material and repairs; second, for fuel. The nitrogenous foods furnish the building material, and the carbonaceous foods the fuels. We have already discussed the carbonaceous foods, this class having been first treated because the foods are somewhat simpler in composition and their use in the body less complicated.

The nitrogenous foods are so called because nitrogen is the most important element in their chemical composition. Besides nitrogen, these foods contain a very large amount of carbon, hydrogen, and oxygen, also small amounts of sulphur and phosphorus. The first foods taken into the animal body are nitrogenous foods, the first need of the animal body being material for growth.

The source of this first food used by animals has already been outlined above. It comes from eggs and milk, milk for the mammals and eggs for all animals lower in rank than the mammals.

A chemical study of these foods prepared for young animals —eggs and milk—shows that in both cases there is an admixture of carbonaceous foods with the nitrogenous. This is indicative of the twofold need of even the youngest animals, whose need for nitrogenous food is simply the predominant need, all the animals, even the youngest, needing also a certain amount of fuel food.

While the *nitrogenous* foods possess a large percentage of proteins and possess also a considerable amount of carbonaceous foods in the form of fat, the oil in eggs is hardly sufficient in quantity to be considered as a dietetic factor. The fat in meat, however, is usually sufficient in quantity to require accurate determination, and to be considered as one of the determined sources of fat. On the other hand, in the *carbonaceous* class all of the vegetables and fruits contain a certain amount of proteins. This protein of the vegetables and fruits is so small in amount as to have little dietetic significance, and may for all practical purposes be ignored. Finally, the *carbo-nitrogenous* foods contain the carbonaceous and nitrogenous foods in fairly well-balanced quantities, and it is because of this balancing of the two foodstuffs that we are compelled to put them in a class by themselves.

The nitrogenous foods, while required in far smaller quantities than the carbonaceous foods, must be looked upon as absolute and

fundamental necessities of life. The amount required by the average individual is between two and four ounces a day, though this is a small amount easily provided from various sources, not only from the meat and eggs, but from milk, cereals, legumes, and nuts. However, this small quantity of nitrogenous foods must be provided day by day throughout life, or there is likely to be a disturbance of the nitrogen equilibrium of the body.

In a brief explanation of what is meant by *nitrogen equilibrium,* it may be said that so long as the body receives enough nitrogen to replace the daily loss of nitrogen the body will maintain a nitrogen equilibrium—that is, it will lose as much nitrogen daily through excretion as it receives through the food. The nitrogen outgo will equal the nitrogen income, thus maintaining the equilibrium.

If the amount of nitrogen received is not sufficient to provide for the repairs—that is, if it is not sufficient to make good the daily loss of nitrogen—there will be a gradual wasting of the active tissues of the body, beginning with the muscles. This wasting of the muscles is possible even while the general body weight is increasing by the deposit of fat. It must be evident that such a process of disturbed equilibrium, or wasting of active tissues, cannot proceed long without serious injury to the body and serious disturbance of its activities.

The first thought that the dietitian should give to a menu is, how much nitrogenous food is needed, and what choice of foods shall be made to provide this need. As stated above, the choice might be confined to the vegetable kingdom, as it would be very easy to procure sufficient protein to maintain nitrogen equilibrium without using any from animal sources, the cereals, legumes, and nuts being all rich in protein. However, human experience seems to indicate that the use of certain animal proteins is essential to the highest physical development. The young mammal, including the human child, is provided by nature with a diet from animal sources alone during the first stage of its development, so that a rational interpretation of nature should not exclude food from animal sources. From the earliest times, man has resorted to the use of eggs as an important addition to his diet. From these sources already named—namely, eggs, milk and vegetable products,

fruits, cereals, and nuts—a complete and wholesome diet may readily be devised. Such a diet is not vegetarian but more accurately called ovo-lacto-vegetarian. Four different kinds of diet are therefore recognized by dietitians. First, *vegetarian;* second, *ovo-lacto-vegetarian;* third, *mixed diet,* consisting of eggs, milk, vegetables, fruits, cereals, legumes, nuts, and the flesh of animals; fourth, *flesh diet,* consisting of the flesh of animals. We find that the last-named diet is the one used by the Eskimos in the Arctic region; the flesh of the seal, the walrus, polar bear, reindeer, and the numerous varieties of fish. While it is true that they sometimes get a little moss and lichen from the stomach of the reindeer that they prepare as a dish which they consider a rare delicacy, and while they occasionally get some milk from the reindeer, still, these substances, not actually from the tissues of animals, are the rare delicacies of their diet and must not be looked upon as a regular and appreciable part.

It must be evident that the reason why the Eskimos are flesh eaters is because they cannot get anything else. They eat what they can get. The more vegetable they can get, the better pleased they are. Subsisting on such a diet, their growth and repair is amply provided for by the lean portion of the animal tissue, while the copious fat deposit of all Arctic animals affords them ample provision for carbonaceous or fuel foods.

Upon such a diet the Eskimos lead an active and vigorous life. Their endurance and resistance to low temperature is shown in their excursions in company with white men in exploring the polar regions. Only the sturdiest white man, prepared by years of experience and training, can keep pace with the Eskimo in these dashes into the far North.

Considering the other extreme of the dietetic gamut, we may discuss the purely vegetarian diet. This consists of vegetables, cereals, legumes, fruits, and nuts. A purely vegetable diet as used by certain tribes in tropical regions and by certain religious votaries and faddists in subtropical regions. If properly selected, it is quite easy to arrange such a diet so that all of the needs of the body will be amply provided for. However, human experience seems to show that the purely vegetarian diet does not produce a people who possess the highest physical, intellectual,

and moral qualities. The world's history does not show that a nation of vegetarians ever reached a high degree of civilization and maintained it for any appreciable length of time. That such is the case, however, must not be assumed to demonstrate that the reason for this is to be found in the diet. Perhaps that is only incidental. Vegetarian races have been tropical people. Their failure to reach and maintain the highest civilization may easily have been the result of the influence of the tropical climate.

The mixed diet consists of meat, eggs, milk, vegetables, fruit, cereals, nuts. In the mixed diet man eats everything that is edible. The people of the temperate zone have from time immemorial used mixed diet. This is probably due to necessity in early human history. They ate animals when they couldn't get vegetables and ate vegetables when they couldn't get animals. They, therefore, early learned to mix the diet, having both animal and vegetable foods in one menu. The cool, stimulating climate of Central and Northern Europe, Asia, and America stimulated primitive man to vigorous activity. He sought excitement. He found it in the chase. After the chase, assuming that to be successful, he barbecued the animal while the whole tribe gathered about and gorged to the limit. When the chase was not successful they usually had stores of cereals and nuts. In the warmer seasons of the year they ate freely of the fruits, berries, and succulent roots that grew on every hand. So we find the aggressive people who have accomplished so much, in the last two thousand years particularly, have used a mixed diet.

It must be evident that the flesh diet of the Eskimo, the vegetarian diet of the inhabitant of the tropics, and the mixed diet of middle latitudes have largely arisen from the necessities and exigencies of the life of primitive peoples in those respective regions. The world's work is accomplished by the people of the temperate zones, and these people use a mixed diet. That there is any causal relation between the diet and their work has not been proven. The relation is probably incidental and due rather to climatic than dietetic causes.

The ovo-lacto-vegetarian diet, last to be considered, is not the result of early human exigency, as were the other kinds of diet,

but has been devised recently as a result of studies in the chemistry of nutrition; that eggs, milks, cereals, nuts, and legumes afford an ample source of nitrogenous foods has been amply demonstrated. Those who advocate this diet emphasize the fact that lean meat, being the muscle tissue of animals, killed in the midst of regular activities, naturally contains a considerable amount of effete and partially oxidized tissue waste on the way to excretion. Ingestion of such waste and semi-waste materials only embarrasses the nutrition of the man and places upon his excretory organs, particularly the kidneys, an extra and altogether unnecessary load of work. These materials would have been excreted presently by the kidneys of the beef creature or the mutton if his physiological activities had not been interrupted in the slaughter house. But having been interrupted, the process must be continued by the man who ingests these materials. Thus the man's kidneys become overworked. Furthermore, it is contended that even a moderate amount of eggs, milk, and legumes and nuts furnishes an ample supply of protein, and that the addition of lean meat to such a diet is so much in excess of the needs of the body, without any reference to the waste products above mentioned, that this excess of nitrogenous material tends to overwork the kidneys, therefore tends to accumulate within the body waste materials and fatigue products, which seriously interfere with all the activities of the body, both physical and intellectual.

In the light of recent researches in nutrition, these points seem to be well taken. An excess of nitrogenous material in nutrition does unquestionably embarrass nutritive processes, and this embarrassment leads surely to interference with the most efficient activity of the body. Whether the solution of the difficulty rests in the adoption of the ovo-lacto-vegetarian diet, or in some other hygienic change, has not been conclusively demonstrated.

Analysis of lean meat has demonstrated the presence of a substance called creatin. This is the substance which gives to lean meat its pleasing flavor, especially developed in the thoroughly cooked meats. Meat extract, beef extract, meat broths, and roast meat owe their pleasing flavor to creatin. Creatin seems to stimulate the appetite. The presence of a small amount of it, in soup or broth, stimulates the secretion of the gastric juice.

Mixed diet into which meat enters may be more condensed—that is, less bulky and more easily digested. Perhaps, therefore, the ovo-lacto-vegetarian diet has no advantages over very carefully chosen mixed diet, in which a moderate quantity of meat is introduced. The most recent researches in nutrition, in fact, tend to show that our mistakes in diet have not been so much in eating meat as the eating of excessive quantities of both meat and vegetables. When an individual eats too much, the error is almost invariably due to the fact that he eats too rapidly. If a person were to eat very slowly, thoroughly masticating every mouthful of food, chewing it until it is reduced to a creamy consistency, he would find after twenty or thirty minutes of such eating that his appetite had become completely satiated. He would also find that he had eaten a very much smaller amount than usual. The digestion of this thoroughly masticated food would proceed so rapidly and with such slight call upon the general system that the individual would be quite unconscious of his stomach and its activities. As the days and weeks go by, the individual adopting such a régime finds that he is maintaining his nutrition on a remarkably small amount of food, and that from this small amount of food he is deriving a remarkably large amount of energy.

Dietary reforms should probably not be in the line of new kinds of diet, but in the line of the moderate, abstemious use of any wholesome mixed diet and its thorough mastication. The most important principle in the choice of diet is to choose one that appeals to the appetite. If one craves meat, let him get it; if he craves milk, or eggs, or cheese, or any particular fruit or vegetable, then let him have this food which he craves. But when he has this longed-for food placed before him, his opportunity for self-restraint has arrived. If he gormandizes on the food he will tax beyond the limit his digestive powers and all those functions which serve the digestion, and greatly embarrass his general activity. If he eats very moderately of this food, chewing it as described above, he will find after twenty or thirty minutes that he has completely satisfied his appetite from a surprisingly small amount of the food. The keen appetite and relish with which he eats the food is the strongest factor in the secretion of the digestive juices. These copious digestive juices quickly perform their function and

within thirty minutes after such a meal the individual is ready to enter upon the strenuous duties incident to modern life.

Under the head of nitrogenous foods we will discuss only two classes, lean meats and eggs. Many writers place milk in this group and call the group " animal foods." In our classification milk is grouped with the carbo-nitrogenous foods because its content of nitrogenous foods is small in proportion to the carbonaceous foods, and further its content of nitrogenous food is not sufficient to justify the use of milk as an especially important source of proteins. Cheese, a milk product, is, of course, largely protein, representing as it does the coagulated proteins of the milk, pressed and cured. The use of milk as the sole food of young mammals during the first stage of their life after birth, and its extensive use as an invalid food, where for days and even weeks it may be almost the only food taken, justifies the classification of milk as a complete food along with legumes, cereals, and nuts.

In our *nitrogenous foods,* then, we will consider only *meat* and *eggs.* When lean meat and eggs are introduced into the alimentary canal, after being reduced to the finest possible state of division in the mouth, they are passed into the stomach, where they are largely transformed, under the influence of the acid gastric juice, into peptones. If they have been properly masticated this peptonizing process is a rapid one, probably consuming not over two or three hours at most. Any portions of the meat proteins not changed in the stomach will be changed by the trypsin of the pancreatic juice. In the condition of peptones the proteins are absorbed and changed back to proteins, in the epithelium of the small intestine, and passed into the blood as serum albumin and serum globulin. In this form they circulate as a part of the blood and lymph until absorbed from these circulating fluids by the active cells of the tissues for use in building and repairing these cells.

It is already stated above that whenever the amount of proteins taken into the body falls short of the amount required, equilibrium is disturbed and a wasting process begins. A question of equal importance is: What happens when the amount of protein ingested exceeds the amount needed for growth and repair?

The proteins in excess of the needs of the tissues for growth and

repair are quickly oxidized. This oxidation yields energy in the form of heat and muscular work, the same as is true in the oxidation of other foods. Incident to this oxidation there appear numerous waste products. When carbonaceous foods are oxidized carbon dioxid is the waste product. When nitrogenous foods are oxidized the waste products consist of carbon dioxid, together with sulphates, phosphates, and numerous nitrogenous compounds. All of these, excepting the carbon dioxid, can pass out of the body only by way of the kidneys, except a small proportion that goes out through the bile.

It is easy to understand that excessive use of nitrogenous foods may readily overwork the organs which excrete nitrogenous waste products. Rightly interpreted, the recent advances of animal nutrition point not toward vegetarianism, but rather toward moderation and mastication.

Class 1. Lean meats include not alone the muscle tissues of beef, mutton, pork, but the muscle tissues of edible animals of all classes. Besides these more common sources of lean meat, there are the domestic fowls: chickens, ducks, geese, turkeys, pigeons, and guinea fowl. Among the game—the four-footed beasts—may be named the deer, bear, elk, moose, mountain sheep, antelope, rabbit, coon, and opossum. And among game birds: wild turkeys, geese, ducks, pigeons, quail, snipe, partridge, grouse, etc.

Fish is another important source of lean meat. Less important are the sea foods, sometimes called shellfish. Among these may be named the lobster, crab, shrimp, oyster, and clam, the edible portions of all these being the muscle tissue, and in the case of the oyster and clam not alone the muscle tissue, but the whole soft body, including the connective tissues, digestive organs, and gills. In glancing at the table showing chemical analysis of meats, note that the proteins of fresh meats range from about fifteen to twenty-five per cent of the whole, while the carbonaceous foods are represented by fats alone, and these range in proportion from one or two per cent up to nearly forty per cent.

Lean meat from all of the sources above enumerated consists of muscle tissue, together with a certain amount of connective tissue, blood-vessels, nerves, and lymphatics. The muscle tissue is essential and is the contractile tissue of the body. The other tissues

are incidental, the connective tissue forming the sheath of the muscle and of muscle bundles, while the blood-vessels and lymphatics bring nourishment in the form of blood and lymph to the muscles and remove from the muscle the waste materials which are collected in blood and lymph. The nerves are branches from the central nervous system and pass from the nervous system to the muscles and control the movements of the latter.

Muscle tissue proper is made up of minute threadlike cells that lie side by side and are so small that the individual cells may be seen by the microscope only. In the living animal the contents of the muscle cells or the contractile tissues are soft and tender, but after death a change takes place in the muscle substance which causes it to become stiff and rigid. This change is called rigor mortis, and consists in a coagulation of the substance of the muscle cells. A similar change can be produced in the muscle of a freshly killed animal by heating it. This condition is known as heat rigor (rigor caloris). In the cooking of freshly killed animals or game, this stiffness of the meat as it begins to cook is easily observed.

The meat from young fat animals is tender, while the meat from old and lean animals is tough. The reason for this may be found partly in the condition of the connective tissue and partly in that of the muscle cells. As an animal advances in age, the connective tissue becomes progressively more and more dense and tough. When fat is deposited within the meshes of the connective tissue, such fat deposit tends to make the connective tissue tender and less resistant and tough. Heavy muscular exercise naturally makes the muscle tissue more dense and firm and tough, and also makes a similar change in the connective tissue. For this reason old work oxen do not make tender beef, nor do old milch cows, age and muscular work both influencing the tenderness of the beef in the same direction. For that reason the choicest animals for food are naturally younger animals, which have not experienced severe muscular work and have been from the first kept plump and fat with good feeding.

In the care of domestic animals, their conditions can easily be controlled so as to produce these desirable attributes, and thus enable the grower to market only the choicest animals whose meat

possesses the qualities above given. Naturally, meats possessing these qualities are the choicest and sell in the market for the highest prices, while meats not of this grade are sold at lower prices and in markets where the purchasers do not insist upon such qualities. In wild animals and game birds, one frequently finds the meat quite tough. This is very likely due to the fact that the animal was subjected to difficult conditions of life, required to take a great deal of strenuous muscular exercise, and frequently left with short rations. While such wild meat and game is highly flavored, it requires careful cooking to make it tender and satisfactory.

The cooking of meat is an important phase of dietetics. A choice piece of meat may be made tough and difficult of digestion by improper cooking, while a tough piece of meat may be made tender and easily digestible by proper cooking. The two essential factors in cooking meat are heat and moisture. The heat develops the flavor, and moisture rightly applied insures tenderness. A piece of tenderloin steak of the highest grade put into a frying pan and fried in grease would be made almost inedible, while a piece of brisket put into a kettle and simmered for hours can be made into a tender, easily digestible, and not ill-flavored dish. In the roasting or broiling of meat several hundred degrees of oven heat rapidly coagulates and sears the outer layer of the meat, thus holding within the meat its juices. If this heat is maintained for a considerable time, differing with the size of the piece of meat being cooked, this retained moisture makes the connective tissue of the meat tender, changing it into gelatin. A considerable time is required to gelatinize connective tissues, therefore meats which contain much connective tissue are not adapted for broiling. They may, however, be roasted, especially if ample provision is made for a frequent and copious basting of the roast. Basting provides the moisture necessary to gelatinize the connective tissue. Where there is a large proportion of connective tissue this process takes considerable time. By devoting sufficient time and attention to some of the cheaper cuts of meat, using this process, the meat may be made appetizing, easily digestible, and wholesome. The boiling of meat produces a similar effect in the connective tissue if the process is longer continued.

Besides developing its flavor and making the meat tender and digestible, sufficient cooking kills any parasites and microörganisms that might accidentally be present in the meat.

Meat Preparations.—Many attempts have been made to produce meat preparations which shall be not only pleasing to the taste, but also nourishing. One of the earliest of these preparations put upon the market was Liebig's Extract of Beef. In more recent times such other preparations as Armour's Extract of Beef, Valentine's Meat Juice, and Wyeth's Meat Juice have been put upon the market. While these preparations contain practically no nourishment, the total proteid matter available for nourishment being, as a rule, about one half of one per cent, still the flavor of these extracts and juices is very pleasing, due to the creatin and related bodies among the extractives, and they may be used in broths, bouillons, and soups to give a meat flavor. Bouillon may be directly prepared from meat by cutting it into small bits or grinding it in a meat grinder, heating slowly for a moderate time, then boiling vigorously for a short time. In this preparation the flavoring materials have been extracted, but the nutrient proteins have been coagulated by the heat and do not appear in the clear bouillon, which has an agreeable appetizing flavor, but represents absolutely no nourishment. Because of its flavor it incites the flow of digestive secretions. Bouillon may be used as a valuable vehicle for cereals, vegetables, and eggs, in soups.

Meat juices, such as Murdoch's Liquid Food, Johnston's Fluid Beef, and Bovinine, contain from nine per cent to fourteen per cent of available protein, and are probably the best preparations of this character.

Meat jellies may be prepared in the home by taking any meat in which there is a large proportion of connective tissue. Put it into cold water in a pot and bring it very slowly to the boiling point, and allow it to simmer for many hours. This slow cooking of the connective tissue gelatinizes it; after it cools, the gelatin may be separated from the fat, bones, and lean meat, and remelted and cooled. This homemade meat jelly usually possesses the pleasing flavors given it by creatin, and is a pleasing addition to the diet of an invalid. However, it must not be forgotten

that gelatin cannot take the place of proteins for growth and repair. It is used in the body practically the same as the carbohydrates and fat—that is, it is a fuel food and not a tissue builder. It differs from the other fuel foods in this, that the waste materials resulting from its oxidation are similar to the waste materials resulting from the oxidation of protein, and must therefore be eliminated by way of the kidneys.

Fish is an important source of protein foods, the flesh of fish being, as a rule, delicate and tender, and possessed of a flavor common to practically all fish, but very different from that of the meat of mammals and birds. In order to develop the flavors of the fish and to insure the killing of any parasites present, it should be thoroughly cooked. The usual methods of cooking fish are frying, baking, broiling, boiling. The flavors are perhaps most highly developed by the first of these methods named. The readiness with which the flesh of fish undergoes decomposition changes makes it necessary either to use this food fresh from the water or subject it to some preserving process, either refrigeration, salting, drying, smoking, or canning.

The sea foods most commonly used may be divided into two groups, crustaceans and mollusks. The *crustaceans* are the lobster, crab, and shrimp. These animals are greenish in color when alive, but on boiling turn bright red. The skeleton of a crustacean is external. It is the skeleton which turns red on boiling. When the exo-skeleton or crust is broken after boiling, the sweet, tender muscle can be readily removed, but while the meat of the crustacean possesses a delicate and pleasing flavor, it is not easily digestible, and for some people seems to be quite indigestible. Lobster and shrimp are largely used in salads, while a common method of serving crab meat is to grind it in a hasher, mix with condiments, and serve in the empty shells as " deviled " crab.

The *mollusks* usually used as foods are oysters, clams, and mussels. As stated above, it is the whole body of the animal that is eaten, including the muscular system, digestive system, gills, and connective tissue. The soft body of the mollusks is occupied very largely by stomach and liver, though as the spawning season approaches the oyster contains a considerable amount of a milky solution which contains the spawn. During the spawning season

Table IV.—Animal Foods

	Water. Per Cent.	Protein. Per Cent.	Fat. Per Cent.	Carbohydrates. Per Cent.	Ash. Per Cent.	Fuel Value per Pound. Calories.
BEEF, FRESH:						
Flank	54.0	17.0	19.0	......	0.7	1,105
Porterhouse	52.4	19.1	17.9	......	0.8	1,100
Sirloin steak	54.0	16.5	16.1	......	0.9	975
Round	60.7	19.0	12.8	......	1.0	890
Rump	45.0	13.8	20.2	......	0.7	1,090
Corned beef	49.2	14.3	23.8	......	4.6	1,245
VEAL:						
Leg cutlets	68.3	20.1	7.5	......	1.0	695
Fore quarter	54.2	15.1	6.0	......	0.7	535
MUTTON:						
Leg, hind	51.2	15.1	14.7	......	0.8	890
Loin chops	42.0	13.5	28.3	......	0.7	1,415
Lamb	49.2	15.6	16.3	......	0.85	967
HAM:						
Loin chops	41.8	13.4	24.2	......	0.8	1,245
Ham, smoked	34.8	14.2	33.4	......	4.2	1,635
SAUSAGE:						
Frankfurter	57.2	19.6	18.6	1.1	3.4	1,155
POULTRY:						
Fowls	47.1	13.7	12.3	......	0.7	765
Goose	38.5	13.4	29.8	......	0.7	1,475
Turkey	42.4	16.1	18.4	......	0.8	1,060
ANIMAL VISCERA:						
Liver (sheep)	61.2	23.1	9.0	5.0	......	......
Sweetbreads	70.9	16.8	12.1	......	1.6	......
Tongue, smoked and salted	35.7	24.3	31.6	......	8.5	......
BRAIN	80.6	8.8	9.3	......	1.1	......
FRESH FISH:						
Bass, large-mouthed, black, dressed	41.9	10.3	0.5	......	0.6	215
Cod steaks	72.4	16.9	0.5	......	1.0	335
Shad roe	71.2	23.4	3.8	......	1.6	595
Whitefish, dressed	46.1	10 2	1.3	......	0.7	245
PRESERVED FISH:						
Halibut, salted, smoked, and dried	46.0	19.1	14.0	......	1.9	945
Sardines, canned	53.6	24.0	12.1	......	5.3	955
Salmon, canned	59.3	19.3	15.3	......	1.2	1,005
MOLLUSKS:						
Oysters, solid	88.3	6.1	1.4	3.3	0.9	235
Round clams removed from shell	80.8	10.6	1.1	5.1	2.3	340
Mussels	42.7	4.4	0.5	2.1	1.0	140
CRUSTACEANS:						
Lobster, in shell	31.1	5.5	0.7	......	0.6	130
Crab, in shell	34.1	7.3	0.9	0.5	1.4	185
Shrimp, canned	70.8	25.4	1.0	0.2	2.6	520
TERRAPIN, TURTLE, ETC.	17.4	4.2	0.7	......	0.2	105

(May to September) oysters are not considered edible. Furthermore, they should be protected during this season from the fishermen, as the supply of oysters is becoming somewhat exhausted. While oysters may be eaten raw, and in this condition are an easily digestible food, one is in some danger of infection.

Class 2. Eggs.—As mentioned above, eggs have been used from time immemorial as a source of nourishment. While eggs of many different species of birds have been at different times used for food, the egg of the domestic fowl is now used almost exclusively by the peoples of Europe and America, and of these the egg of the hen is used in vastly the greatest numbers. The hen's egg is practically the only egg found in the metropolitan markets, the eggs of the duck, goose, turkey, and guinea fowl being used principally in the rural districts where they are produced. While eggs contain a considerable amount of fat, approximating ten per cent, this does not make a sufficient amount of fat, even in the half dozen eggs that might be taken in one day's rations, so that we would be justified in looking upon the egg as an appreciable source of fat. We eat the egg because of the protein. It is a most wholesome source of protein, and therefore is classified here as a nitrogenous food. The fat of the egg is contained in the yolk, which is about one third fat. Egg fat, as extracted with ether, is a yellow oil composed largely of olein with a slight admixture of palmitin and stearin. Egg protein consists of a mixture of several albumens and globulins. The principal albumen of the white is called ovalbumen, the principal protein of the yolk is vitellin. The egg does not possess a clearly marked flavor. For this reason it is customary in the cooking of eggs and milk in custards, neither of which constituent possesses a marked flavor, to add some flavoring material. It often happens, however, that the food used by the hen possesses a strong flavor, and this may, in turn, influence the egg, giving it a flavor which may be disagreeable. If eggs are not absolutely fresh they are likely to get a strong, disagreeable flavor. It is important to be able to test an egg to determine its freshness. Several methods have been devised. If one clasps an egg in the two hands looking through the egg at a candlelight, the hands shutting out all the light that does not come through the egg, a perfectly fresh egg seems trans-

lucent and unclouded. In an egg which has been incubated, or has been for a few days under a setting hen, a dark spot is visible, which increases in size according to the length of time the incubation has continued. An egg in which decay has begun is dark-colored. Another method of determining the freshness of eggs is to float them in a brine made in the proportion of two ounces of salt to a pint of water. In such a brine a fresh egg will sink at once to the bottom, while eggs one, two, and three days old will rise nearer to the surface. After the third day the surface of the shell will appear above the liquid, and with increasing age a progressively larger and larger portion of the shell will be exposed above the level of the liquid. Eggs are, as a rule, easily digestible, even when hard boiled, if they are masticated until they are reduced to a smooth, creamy consistency. Eggs are used very largely in combination foods where they are mixed with milk, flour, starch, etc., in the making of custards, puddings, breads, and cakes. Such combinations will be discussed later. In the separate cooking of eggs we may describe the simplest first. The boiling of an egg may be accomplished in three different ways: If an egg is dropped into a pint of actually boiling water, and if the water is kept actively boiling for three minutes, the egg at the end of that time will be in the condition known as "soft-boiled." The soft-boiled egg when properly prepared should present the yolk in a creamy condition, and the white soft and gelatinous, but cooked through. If the boiling is continued for a longer period the white and yolk become progressively more and more dense and hard until after fifteen or twenty minutes of boiling the yolk finally becomes mealy in consistency and the white hard and leathery. However, even in this condition the yolk may be very easily masticated, and the white, if masticated sufficiently long to reduce it to a fine state of division, is not difficult to digest. In soft boiling eggs there should be about a pint of water to each egg, otherwise if several eggs are put into, say, a quart of water, the temperature will be so appreciably lowered by the introduction of the eggs that the active boiling will cease for a minute or two. At the end of the three-minute period, if the eggs are taken out, it will be found that they are barely warm through, the white being not yet coagulated.

Another method of boiling eggs is to put the eggs into actively boiling water, the proportion of one egg to a pint of water, and stand them aside away from the stove for a period of six minutes. At the end of that time they will have been cooked through, and will represent the condition similar to the soft-boiled egg mentioned above. This method has the advantage of cooking the yolk much more thoroughly than can be done in the three-minute process.

A third method used by some is to put the eggs into cold water, proportioned as above, a pint to an egg, and let the water come to a boil. As soon as the water begins to boil lift the eggs out of the water and throw a dash of cold water over them. This last method produces results very similar to the second method described. Some prefer one of these methods and some another, it really doesn't matter from a dietetic standpoint. Let one use the method which he likes best, feeling assured that that is the proper method. The only thing that does matter is this: that whenever the white of the egg is coagulated by the heat, it must be divided by mastication into the minutest possible divisions. When so divided it is quickly digested and changed in the stomach to peptone, absorbed as such, changed in the epithelium to serum globulin and serum albumin, and carried to the tissues to be used as are the serum albumin and serum globulin derived from the digestion of meat proteins.

The importance of eggs as a source of iron has been mentioned above, and a special egg preparation, egg lemonade, has been mentioned. It is probable that no more easily digested food can be prepared than egg lemonade. While it is prepared in a special way when it is prescribed for the purpose of increasing the red coloring matter of the blood, if it is to be used for purposes of general nutrition the whole egg, yolk and white, is made into a glass of egg lemonade, through the addition of the juice of half a lemon, sugar to taste, water sufficient to fill the glass and iced. As one is preparing such a lemonade, he will notice that after the lemon juice has been added to the egg and beaten, the egg presently loses its ropiness and becomes limpid like milk, though yellow in color. This change in the consistency of the egg from viscid to limpid marks a change in the chemical composition of

the egg. After it becomes limpid it is no longer unmodified albumin, globulin, and vitellin, but has, under the influence of the citric acid of the lemon, been changed to acid albuminate. This acid albuminate represents a mid stage of digestion of proteins. Of the digestive process it remains simply to change the acid albuminate to proteoses and peptone. This is quickly accomplished by the pepsin of the gastric juice. Invalids who can with difficulty retain solid foods, and digest them, find in egg lemonade a food not only most pleasing to the taste, but one which is readily retained and easily digested and assimilated.

Other preparations of raw egg may be valuable to serve as a variety in cases where it is necessary to give a considerable number of eggs for days or weeks in succession. While raw egg may be taken directly from the shell, and swallowed quickly without chewing, to many people this is a difficult process which may even lead to nausea. Among the vehicles that may be used to carry raw eggs, there may be enumerated, besides the lemon juice mentioned above, orange juice, grape juice, milk, coffee, cream, and cocoa. When used with any of these vehicles the eggs should, of course, be beaten, the flavor of the vehicle usually veiling the flavor of the egg, which to many people is not particularly pleasing. Eggnog was originally prepared from milk and eggs flavored with whisky or brandy and sweetened with sugar; however, the recipe now most used in hospitals omits the liquor and substitutes any strong flavor.

Division C. Carbo-nitrogenous Foods.—As has been stated, this division of organic foods includes those foods which contain too much nitrogenous material to justify their classification among the carbonaceous foods, and too much carbonaceous material to justify their classification among the nitrogenous foods. For example, such a cereal as rolled oats, with its 16.7 per cent protein, cannot surely be classified among the carbonaceous foods, because these, as a rule, do not contain more than four or five per cent of protein at the most, while many of them contain only a small fraction of one per cent. On the other hand, rolled oats should not be classified with the proteins because they contain over seventy per cent of carbonaceous material, mostly carbohydrates. These carbo-nitrogenous foods have been called perfect or com-

plete foods, because they satisfy all of the requirements of the body, and one could live for an indefinite period on any one of these complete foods. A young animal can get sufficient protein from cereals to provide all the necessary material for the growth of any tissues of the body. Furthermore, he can get from the cereals all the carbonaceous material necessary for body fuel. In a similar way legumes or nuts or milk will furnish all the food materials necessary to maintain life and all of the functions of the body for an indefinite period. It is, however, exceptional for human dietaries to be reduced to such great simplicity; even when cereals are freely used there is uniformly a large admixture of milk, eggs, fruits, and vegetables.

Class I. Cereals.—Cereals are the seed of cultivated grasses. This name dates back to mythological times when the goddess Ceres is supposed to have been first to cultivate these grasses and to gather their seeds for food. Among the cereals, wheat, rice, corn, rye, oats, and barley are the most important, and are named here in the order of their importance. As a rule, these grains are ground into meal or flour. However, rice and barley are usually found in the market hulled, though rice flour and barley meal are also used to a limited extent.

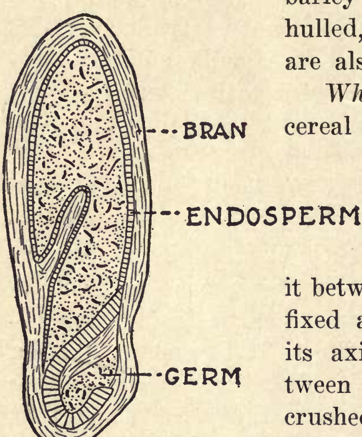

Fig. 2.—Wheat Grain (longitudinal section).

Wheat.—Wheat is the most widely used cereal in America and Europe. While it is sometimes used unground, it is used in vastly greater proportions ground into flour. The old process of milling flour was to grind it between two stones, the lower stone being fixed and the upper stone rotating about its axis. The wheat berries coming between these stones from the hopper were crushed into a fine powder, and this, through a process of sifting and bolting through fine sieves and bolting cloth, was divided into bran, middlings, and white flour. The bran and middlings represented no small part of the nutritious portion of the wheat, particularly the gluten. When

Table V.—Cereals

	Water. Per Cent.	Protein. Per Cent.	Fat. Per Cent.	Carbohydrates.		Ash. Per Cent.
				Starch, etc. Per Cent.	Crude Fiber. Per Cent.	
Wheat	10.4	12.1	2.1	71.6	1.8	1.9
Rice	12.4	7.4	0.4	79.2	0.2	0.4
Oats	11.0	11.8	5.0	59.7	9.5	3.0
Rye	11.6	10.6	1.7	72.0	1.7	1.9
Breads and Crackers:						
Wheat bread	32.5	8.8	1.9	55.8	......	1.0
Graham bread	34.2	9.5	1.4	53.3	......	1.6
Rye bread	30.0	3.4	0.5	59.7	......	1.4
Soda crackers	8.0	10.3	9.4	70.5	......	1.8
Graham crackers	5.0	9.8	13.5	69.7	......	2.0
Oatmeal crackers	4.9	10.4	13.7	69.6	......	1.4
Oyster crackers	3.8	11.3	4.8	77.5	......	2.6
Macaroni	13.1	9.0	0.3	76.8	......	0.8
Flours and Meals:						
Flour, wheat	12.5	11.0	1.0	74.9	......	0.5
Corn meal	15.0	9.2	3.8	70.6	......	1.4
Oatmeal	7.6	15.1	7.1	68.2	......	2.0

Omit

the ground wheat was not separated by the bolting process it was called graham flour. Real graham bread should be made from such flour, rather than from any preparation that is being made by the roller process.

The modern milling of wheat is done by crushing the dried, clean berry between steel rollers. This roller process has two distinct advantages over the stone process: First, it separates the gluten layer completely from the bran or epidermis and crushes it so fine that it passes directly into flour. For that reason, the white flour of the roller process contains a larger portion of nutrient, particularly of nitrogenous nutrient, than does the white flour of the stone process. The second advantage of this process is that it facilitates the preparation of a "whole wheat flour," which contains absolutely everything within the epidermis of the wheat berry. It contains the whole gluten, it contains the germ with its rich proteins and oils, it contains all the salts and all the starches. This whole wheat flour is the most perfect cereal product that the ingenuity of man has devised. From it breads and

biscuits, and crackers, cakes, and pastries in great variety may be made.

In recent years a large number of *wheat preparations* have been put upon the market to be used as breakfast foods. These preparations, such as vitose, cream of wheat, Pettijohn's breakfast food, wheatlet, etc., are all wholesome and highly nutritious. No one of these preparations can be said to possess distinct advantages over any of the others. They all require cooking before they are served. The time required for this cooking should be not less than three quarters of an hour, preferably two or three hours. They should be cooked in a double boiler. However, an even better method than this is the "fireless cooker"; stirring the preparation into boiling water in the proportions indicated in the recipe, one maintains the mixture at the temperature of active boiling for a period of about ten minutes, then places it in the fireless cooker, where it remains for eight to twelve hours—i. e., from evening until the next morning. When the lid is removed in the morning it will be found to be smoking hot and very thoroughly cooked. When these preparations are thus thoroughly cooked and thoroughly masticated they are most wholesome and palatable, and may well make an important part of the menu.

There is probably only one criticism to be directed against cereal breakfast foods prepared in this way, and that is that *they require no work on the part of the teeth.* Even if one goes through the motions of chewing, which is really difficult in case of a thoroughly cooked cereal, still, the soft food affords no resistance to the teeth. As a result of this eating of soft foods, the teeth may and probably will enter into early decay. Dentists report a great prevalence of tooth decay and degeneration due, without doubt, to the general use of soft-cooked breakfast food. At every breakfast where these boiled cereals make an important part of the meal there should also be served some hard resistant food, like dry toast, which gives the teeth the required exercise.

Breads.—The most widely used wheat food is bread, and this exists in many different forms and varieties. As made in the home bread is usually made from a yeast "sponge," prepared by mixing the yeast with a flour batter and leaving it to ferment

for several hours. When the whole sponge is in active fermentation more flour is added to make a stiff dough. This dough is usually kneaded with the hands, which kneading process distributes the ingredients, especially the yeast, evenly through the dough. It is necessary to keep the bread sponge as well as the dough in a warm place in order that the yeast may do its work rapidly.

The yeast is a plant fungus, and fermentation is a process which simply represents the feeding of the yeast. The yeast consumes sugar, changing it into alcohol and carbon-dioxid gas. If sugar is not present, the yeast may use starch, breaking it up into sugar, and then further breaking it up into alcohol and carbonic-acid gas. Because of the fact that the yeast begins its action more readily with sugar than with starch many bread makers add a very small amount of sugar to the sponge. As this is all consumed in the fermentation of the sponge, it does not have the effect of sweetening the bread. In making the sponge milk is sometimes used instead of water for the liquid, and not infrequently "potato water," in which there is a considerable amount of starch. These variations in the liquid used for the sponge vary the quality and texture of the bread, the potato water making a bread which retains its moisture longer than bread made by other methods. Milk bread is likely to be finer in texture and is somewhat more nourishing than water bread because of the food value of the milk.

The action of the yeast is to cause the lightness of the bread, accomplished through the liberation of the carbon-dioxid gas, which cannot escape from the dough, being retained by the elastic gluten. This retained gas appears in fine bubbles through the dough, causing it to rise, increasing the loaf very greatly in size and making it light and spongy. Naturally, the best flour for bread making is a flour rich in gluten. These flours especially rich in gluten are called "strong flours," and are made from the hard wheat grown in northern districts. The wheat of softer berry, especially winter wheat from farther south, makes the "weak flour," so called, which contains a smaller proportion of gluten. While especially adapted for pastries and cakes, these flours are somewhat less adapted to bread making.

In the making of bread alcohol forms in the sponge and dough incident to the yeast fermentation. It is driven off in the baking; hence, properly baked bread contains absolutely no free alcohol. Furthermore, the yeast, which is composed of living plant cells, is killed. If the bread is not thoroughly baked some of the alcohol may be retained and the life of the yeast may not be completely destroyed; as a result such bread becomes sour within a day or so after it is baked, through a further fermentation of the alcohol, and a possible further activity of the yeast.

Graham bread is made in a general way similar to white bread and made from graham flour. Any advantage which graham bread possesses over white bread is due to the presence of the bran in the flour. This presence of the bran may serve to stimulate the peristaltic action of the intestinal walls, thus the graham bread is likely to be more laxative than the white bread. However, graham and whole wheat bread contain a larger proportion of indigestible material than is the case with white bread.

Hot breads may be made with yeast as a leavening agent, but such breads are more likely to be made with baking powder. Baking powder of the best quality is a combination of bicarbonate of soda and cream of tartar. When these two substances are brought together in the presence of moisture a combination is formed which results in formation of sodium tartrate, which remains in the bread after baking, and carbon dioxid, which escapes into the dough and causes it to rise, as does the carbon dioxid escaping in the process of yeast fermentation.

Some breads are unleavened, as is the case with the common white crackers, the lightness of these being partly due to the kneading of the dough. This process is done by machinery, and the result is somewhat more of a pastry than a bread. The lightness and flakiness of properly made pastries is due to the admixture of shortening, and in no small measure to the particular way in which the shortening is mixed with the flour.

Rice.—This cereal is next to wheat used more widely for food than any other cereal; especially is it the staple cereal in southern and eastern Asia, where hundreds of millions of people depend upon it as the chief source of their starchy foods. Rice is grown in low alluvial plains, and requires in the early part of its growth

that the field on which it is growing be actually flooded with water. This requirement of the growing rice confines its production to limited districts. The freshly gathered rice has a brownish coat that sticks to the kernel. This coat being altogether indigestible and chaffy in its consistency must be removed from the rice grain in order to make that edible for the human subject. As rice appears in the market, then, it consists of the hulled berries of the cereal. Rarely it is milled and made into flour or meal, but as rice flour contains only a very small percentage of gluten it does not respond to yeast or baking powders, and is therefore not a bread flour. As a rule, rice prepared for the table is simply boiled. When this is properly done the rice grains are cooked soft throughout, but retain their form.

In Europe and America rice is used very largely in desserts and side dishes, its large proportion of starch and small proportion of protein probably accounting for its place in the dietary.

Corn.—Indian corn or maize is a cereal peculiar to America, and very widely used throughout this country. As a rule, it is used in the form of a rather coarse meal, seldom as a bolted flour, its shortcomings as a flour for leavened bread being similar to those of rice, and due to its lack of gluten. Like rice, the corn has a rather tough, scaly epidermis. Whenever the corn is used as whole grains its epidermis must be removed. This "hulled" corn is known in the market as hominy. In the use of corn in the form of meal the hull is ground with the berry, and in many meals it is not removed by a sifting or bolting process. However, the quality of the meal is improved by the removal of the hull, unless this is very finely ground. Corn meal may be used as a cereal breakfast food, not uncommonly used in the so-called corn-meal mush, though it is more widely used in the various forms of corn bread and corn muffins. In large districts in the Southern States corn is almost the only cereal food used.

Green Corn.—When the corn is in the milky stage of its development, which it reaches in July and August, the kernels are sweet and tender and possess a flavor pleasing to most people. This green corn is gathered from the fields and gardens, and appears in the markets early in July and for about two months following. Green corn is prepared by boiling the ears for about

twenty minutes. It may then be served on the cob or shaved from the cob and served with butter or butter and milk as a side dish. The varieties of corn served in this way are usually the so-called "sweet corn." Sweet corn possesses a very much larger amount of sugar than field corn, and is therefore much better adapted for this use. Sweet corn is never ground into meal, though it appears in recent years as parched berries or kernels among the "pure-food" preparations.

Rye.—Rye has many points in common with wheat in its natural growth and in its use as a food. It is ground into flour and meal similar to wheat and used very largely in northern Europe for bread. Rye bread is much darker than wheat bread; in fact, it is as dark as the whole wheat bread and somewhat similar to whole wheat bread in texture. It has a very different flavor, however, and because of its greater proportion of cellulose, is somewhat less nourishing than bread made from wheat. When properly made the rye bread has a fine texture and the loaf retains its moisture longer than the wheat loaf, perhaps because of its finer texture.

Oats.—Oats were defined by the lexicographer Johnson as "food for horses in England and men in Scotland." A canny Scotchman, reading that definition, remarked: "And where do you find such horses as they have in England or such men as they have in Scotland?"

As a matter of fact, oatmeal in the form in which it is usually put upon the market for human food shows on analysis a very high protein content—in short, it is the most nutritious of the cereal products, and it is likely that no cereal is better adapted for the maintenance of life and energy than is oatmeal. It appears in the markets in two different well-known preparations: the old-fashioned oatmeal, such as has been used for generations by the Scotch for their nourishing, appetizing porridge, and the oat flakes prepared by crushing the oat berries by a roller process, and steaming them for a considerable time, thus partially cooking them. The rolled oats thus prepared make one of the best of the cereal breakfast foods, and have the advantage of requiring less cooking than the oatmeal. A very common mistake, however, is to cook the rolled oats too little. They require, like the wheat

preparations, at least forty-five minutes in a double boiler. The cereal would be much more wholesome and easily digested if prepared in a " fireless cooker," where it would be under the influence of nearly a boiling temperature for from eight to twelve hours. The oatmeal should never be served until it has been cooked in a double boiler for two or three hours, or in a fireless cooker overnight.

Barley.—This grain looks somewhat like the rice grain when it comes from the threshing machine, and, like the rice kernel, barley has a shell which cleaves tight to the berry, and needs to be removed before the cereal is edible. This hulled barley, while sometimes milled into flour or meal, has very limited use in this form, its usual use in the dietary being in the hulled berries. It looks not unlike rice, and may be used in a similar way, though its most general use is as an adjunct for soups.

CLASS 2. LEGUMES.—The legumes are the seeds of peas, beans, lentils, and peanuts. These seeds differ from the cereal seeds in containing a very much larger proportion of protein, as is shown by the accompanying table, which sets forth the chemical composition. Because of their richness in proteins, the legumes may be used in the dietary as a source of protein food next in importance to eggs and meat. In all dietaries which are vegetarian or ovo-lacto-vegetarian in character, it is customary to make very frequent use of the legumes to replace the meat of the ordinary mixed diet. A sandwich of peanut butter spread upon thin slices of bread would be quite as nourishing as a ham or tongue sandwich, and chemical analysis would show it to contain about the same amount of protein. Baked beans may well be used as a substitute for the meat of a dinner menu. The protein of the legumes is in the form of legumin, which is so much like the casein of milk that it has been called vegetable casein. This protein of the legumes is less easily digestible than meat protein.

The very thorough cooking of legumes is even more important than the thorough cooking of other foods. This prolonged cooking is necessary, owing to the fact that the nutrients are inclosed within the walls of the plant cells, which makes them inaccessible to the digestive juices until the cell walls are broken down by cooking and mastication. The grinding of dried legumes into

Table VI.—Legumes

Material.	Water. Per Cent.	Protein. Per Cent.	Fat. Per Cent.	Carbohydrates. Per Cent.	Ash. Per Cent.	Fuel Value per Pound. Calories.
Dried Legumes:						
Navy beans	12.6	22.5	1.8	59.6	3.5	1,605
Dried peas	9.5	24.6	1.0	62.0	2.9	1,655
Lentils	8.4	25.7	1.0	59.2	5.7	1,620
Lima beans	10.4	18.1	1.5	65.9	4.1	1,625
Peanuts	9.2	25.8	38.6	24.4	2.0	2,560
Peanut butter	2.1	29.3	46.5	17.1	5.0	2,825
Fresh Legumes:						
Canned peas	85.3	3.6	0.2	9.8	1.1	255
Canned lima beans	79.5	4.0	0.3	14.6	1.6	360
Canned string beans	93.7	1.1	0.1	3.8	1.3	95
Canned baked beans	68.9	6.9	2.5	19.6	2.1	600
String beans	89.2	2.3	0.3	7.4	0.8	195
Shelled peas	74.6	7.0	0.5	16.9	1.0	465

meal greatly facilitates the cooking and the mastication, and therefore in turn the digestibility. Owing to the fact that dried legumes, such as the navy beans and the dried peas of the market, are rather difficult of digestion, they are less adapted for general use in the dietaries of people of sedentary occupation than for those who are engaged in active out-of-door pursuits. In the dietary of the lumberman, boiled or baked beans appear as almost a daily ration throughout the winter season.

Besides the large proportion of protein, the legumes show a very high percentage of carbohydrates, mostly starch, but only a trace of fat, excepting the peanuts, which are very rich in fat and show only a moderate amount of carbohydrates. Because of the small proportion of fat in beans, peas, and lentils, that food should be added in the preparation. A common method of adding the required fat is to bake or boil fat meat with the legumes, as in the case of boiled or baked pork and beans. When fat has been thus added, the combination is a complete food, having the three organic foods in a proportion which would sustain life for an indefinite period. In the preparation of dried legumes, as dried peas and beans, one should avoid the use of hard water, as the mineral salts in hard water tend to form a combination with the legumin which makes the seeds hard and almost indi-

gestible. The use of soft water, or even distilled water, will avoid such a result. Even the salt used in seasoning should be added as late as possible in the process of cooking. If soft water is not to be obtained a little baking soda may be added to the water, in the proportion of half a teaspoonful to two quarts. This softens the shells and overcomes in a large measure the influence of any calcium and magnesium salts present.

Green beans and peas have been mentioned above under green vegetables. Green beans, string beans, or snap beans appear in the market in early summer, and it is the whole bean pod with the contained young bean that is used. The crisp succulent pod is tender and luscious after brief boiling, and may be served as a side dish with butter or a cream dressing. At a later stage in their development the beans are greatly increased in size at the expense of the pod, the latter becoming thin and leathery. When the beans have reached this stage of their development they should be shelled; the shelled green beans may be prepared and served like green peas. At a somewhat later stage in their development they may be baked. These moist ripening beans from the garden bake very easily as compared with the dried beans of the winter market, and possess all of the nourishing qualities of the dried beans, besides being more easily digested.

Green peas are never eaten with the pod, but are shelled, and like the beans they may be used at various stages of their development. When too mature to serve as green peas, they may by longer boiling be made into a delicious purée by removing the tough skin of the seed and passing them, when thoroughly cooked, through a sieve.

Lentils are used in the menu like dried peas. They are not in common use in this country, and are seen only in the metropolitan markets.

Peanuts.—While peanuts are legumes, their large proportion of oil gives them an important point of similarity to nuts in their chemical composition. Furthermore, their use has been like that of nuts rather than that of legumes. Peanuts, like the other legumes, require cooking to make them edible. They are not usually boiled or baked, but rather roasted. This roasting is usually done while the peanuts are still within the shell. The roasting

develops the flavors of the peanut as any other methods of cooking could not do. The large percentage of protein and the division of the carbonaceous foods among starch, sugar, and fats makes the peanut one of the best-balanced food materials available. It is likely that one could maintain life and a normal condition of the body for an indefinite period on a diet of peanuts alone. If one were to seek some food to eat along with peanuts, which would maintain the body in a condition of proper nourishment, he might well choose a fruit, such, for example, as the apple. On a diet of peanuts and apples, assuming that these foods were taken abstemiously and were very thoroughly masticated—in fact, pulverized—the body would be maintained in a proper state of nutrition for an indefinite period.

The expressed oil of the peanut is excellent for table use, probably second only in quality to olive oil, and, like olive oil, possessing a sweetish, pleasant flavor.

The roasted peanuts divested of their thin brown coat may be ground into a paste. The pasty consistency of the ground peanut is due to the large percentage of oil. This paste is found in the market as peanut butter. It may be prepared in the kitchen by passing the roasted peanuts through a meat hasher and perhaps further crushing them under a potato masher or pestle.

Class 3. Nuts.—Nuts are the seeds of certain trees and shrubs. The typical nut possesses a dry, woody outer shell, and a dry, brownish inner coat. The "meat" or kernel of the nut may be readily removed from the shell after the latter is crushed, but it retains its inner coat in the form of the brown epidermis of the kernel. This inner coat is usually eaten with the kernel, though it is possible to remove it by loosening it through the action of actively boiling water, after which it can be slipped off easily between the fingers. The classification of nuts along with the carbonitrogenous foods is justified by their high percentage of protein and of carbonaceous foods. In almonds, for example, which may be taken to represent an average, the edible portion contains twenty-one per cent of protein and over 72.2 per cent carbonaceous food, of which about fifty-five per cent is fat. Of the carbohydrates, besides cellulose, which is practically indigestible, there is a small amount of sugar in most nuts and a large amount of

Table VII.—Nuts

	Water. Per Cent.	Protein. Per Cent.	Fat. Per Cent.	Carbohydrates. Per Cent.	Ash. Per Cent.	Fuel Value per Pound. Calories.
Almonds..................	4.8	21.0	54 90	17.3	2.0	3,030
Brazil nuts................	5.3	17.0	66.80	7.0	3.9	3,329
Filberts....................	3.7	15.6	65.30	13.0	2.4	3,432
Hickory nuts..............	3.7	15.4	67.40	11.4	2.1	3,495
Pecans.....................	3.0	11.0	71.20	13.3	1.5	3,633
English walnuts............	2.8	16.7	64.40	14.8	1.3	3,305
Chestnuts, fresh............	45.0	6.2	5.40	42.1	1.3	1,125
Walnuts, black.............	2.5	27.6	56.30	11.7	1.9	3,105
Cocoanut, shredded.........	3.5	6.3	57.30	31.6	1.3	3,125
Peanuts, roasted...........	1.6	30.5	49.20	16.2	2.5	3,177

starch in some nuts. Chestnuts, for example, contain a large amount of starch. For that reason it is necessary to cook chestnuts. Fresh chestnuts just as they are gathered from the woods are frequently boiled, though the most prevalent method of preparing chestnuts is to roast them in a pan over the coals. Nuts have been looked upon as being difficult of digestion; some people seem to find them altogether indigestible. This bad reputation has undoubtedly been gained through the unwise use of nuts. If made a part of the regular menu at all, they have usually been used with figs or raisins as a sort of postprandial dessert—after the long-suffering stomach has already been gorged to the limit. Taken in this way it is easy to understand that nuts may serve as the last straw and be the precipitating cause of a case of indigestion.

When nuts are taken seriously and introduced into the dietary as an important source of protein, and introduced into the menu at such a point that they will receive the attention due them, there is no reason why they should not be as readily digestible as cereals or legumes. It goes without saying that this food taken raw, as it usually is, should be very thoroughly masticated.

A favorite way of introducing nuts into the menu is as a part of a salad. In the vegetarian diet nuts are frequently passed through the meat hasher, reduced to a sort of paste, which, with some cereal or vegetable admixture, is fried or baked and served in the place of a meat course. Such preparations are wholesome

and nourishing, and to most people easy of digestion. Another favorite method of serving nuts is as a side dish in the dinner. Blanched almonds, salted and roasted, are a common nut for this purpose, though others may be similarly used. If a meal has been poor in proteins, a proper dessert might be one of nuts alone, where English walnuts, almonds, pecans, or other nuts could be served and take the place of a heavy pudding. If nuts taken in this way to supplement proteins are very thoroughly masticated, it is inconceivable that they should be less digestible than the heavy puddings that are sometimes used for desserts.

From a strictly dietetic standpoint they are certainly much more to be recommended than puddings and pastries.

Class 4. Milk.—This is a complete food because the various foodstuffs exist in proportions and in quantities sufficient to sustain life for an indefinite period. While milk in Nature's plan is the sole food for young mammals, man has learned to use milk under all conditions and ages as a most wholesome and pleasing source of nutriment. While the milk of goats, and perhaps of other animals than the cow, is used in some countries, an overwhelming preponderance of milk used as human food is the milk of the cow. Cow's milk possesses only about thirteen per cent of nutriment while about eighty-seven per cent is water. However, when we remember that for young mammals the milk is both food and drink, we can easily understand why it should have these proportions. While milk is both food and drink for the young, it must not be looked upon as a proper agent for slaking thirst after the infantile stage. To take a glass of cold milk one or two hours before a meal to slake thirst would have the unfortunate result of failing to slake the thirst, besides introducing into the stomach a food whose presence would require all the digestive powers of the stomach, and as these would be in the midst of their activity at mealtime, there would be little or no appetite for further food. This interference with the regular digestive work of the stomach and disturbance of the appetite is sufficient reason for discouraging the use of milk between meals as a beverage. In the dietary for the well and sick, milk must be looked upon as food and not as drink, and it should never be given unless we wish to give food.

Table VIII.—Milk and Milk Products

	Water.	Proteins.	Fats.	Sugar.	Salts.	Lactic Acid.
Milk	86.8	4.0	3.7	4.8	0.7	....
Skimmed milk	88.0	4.0	1.8	5.4	0.8	....
Buttermilk	90.6	3.8	1.2	3.3	0.6	0.3 ..
Cream	66.0	2.7	26.7	2.8	1.8	....
Cheese	36.8	33.5	24.3	....	5.4	....
Butter	6.0	0.3	91.0	....	2.7	....

The thirteen per cent of organic food in milk is nearly equally divided between the butter fat, milk sugar and casein. The fat is emulsified, the minute fat droplets being each contained within a thin albuminous covering. When milk is allowed to cool and stand in receptacles free from any agitation, the milk fat will rise to the top in the form of cream. If this cream is skimmed off, and thoroughly shaken and beaten, the pellicles of the fat globules are broken; the fat globules than readily coalesce first into small masses, then into larger masses called butter, while the remaining portion of the cream representing the broken pellicles, together with milk sugar, and some casein, is called *buttermilk.* As a rule, the sugar has undergone partial fermentation and there is enough free lactic acid present in buttermilk to give it a definitely acid taste. *Butter* is one of the most easily digestible and at the same time most complex fats used in the dietary. While it is made up largely of a mixture of olein, palmitin, and stearin, these are not simple mixtures, such as we find the fat deposited in animal tissues, but they are so combined that one molecule of palmitic acid, a molecule of oleic acid, and a molecule of butyric acid, are joined as glycerids in a single fat molecule.

Milk, as found in the markets, is more likely to vary with respect to its fat contents than with respect to any other constituent. Therefore, in the inspection of milk the most important thing to determine is to find whether the proper proportion of butter fat is present. While the butter fat constitutes about 3.7 per cent of whole milk, or about 31 per cent of the total solids, it is more subject to variation than any of the other constituents. So that in fixing a standard the minimum of three per cent fat is usually

allowed. However, this is greatly exceeded in milk that comes from certain breeds. The Jerseys and Alderneys, for example, produce a milk whose fat usually reaches five per cent or even more. In the inspection of milk the total solids are usually also determined. If these fall below twelve per cent there is ground for suspecting that water has been added to the milk. A not unusual method of modifying the milk is to add a little water or remove a little cream. As the removal of cream or the addition of water tends to make the milk less rich in color, a small amount of coloring matter is sometimes added. These adulterations, however, are not difficult of detection if they are repeated regularly by any dairyman.

Two facts make it difficult positively to detect adulteration of milk with water, or the removal of a small portion of the cream. These two facts are, first, that cows of different breeds produce milk that varies considerably in fat, as indicated above, and second, cows of a particular breed or individual cows will vary considerably from time to time in the composition of the milk, especially with reference to the fat. Illustrative of the first fact, we may cite the difference between the milk of Jerseys and Alderneys on the one hand, and Holsteins on the other. The former produce a very rich, yellowish milk, whose five per cent of cream rises rapidly, separating almost completely from the milk, which is left blue and thin. The milk of the Holstein is very much more voluminous in quantity, is so much poorer in fat that the dairymen, who have herds of Holsteins, frequently have difficulty in passing the lower limit prescribed in the inspection. In the milk of such breeds as Durhams, Holsteins, and others, the cream rises more slowly and less completely than in the case of Jersey milk. Of these two general types of milk, the Jersey type is better for butter making, while the Holstein type is better for all purposes where the milk is to be used as whole milk, being unseparated.

Reference was made above to variation in the milk of the individual herds of cows, this variation being due largely to a difference in the drink. Cows that are in dry pasture in hot August weather are likely to drink so freely of water to slake their thirst that they actually dilute the milk to where it may fall below the minimum required by inspection. Dairymen have

learned that under such conditions cows should be kept in during the hot portion of the day and given a good feed of nourishing food.

Contamination of milk should be strictly guarded against and a thorough inspection should determine not only the fault mentioned above, but should also detect such grosser contamination as the presence of barn manure or hair. These evidences of filth and uncleanliness get access during the milking process usually falling from the udder into the milk pails. Such gross contaminations are, in the light of modern dairying, absolutely without excuse. In a well-conducted dairy, not only are all the cows in a condition of good health, but they are kept in clean stalls. The dairyman washes the udder of the cow, brushes her sides, and also washes his own hands before he begins to milk. Not infrequently the further precaution is observed of straining the milk through a gauze top placed over the milk pail. This catches any hairs that may be accidentally dislodged from the udder. After milking, the milk is very carefully strained so as to remove larger dust particles and is at once subjected to a chilling process that lowers the temperature to about 50° F., at which temperature it ought to be maintained until used.

The object of thus reducing the temperature is to decrease the bacterial multiplication. All milk contains a certain number of bacteria. These are usually nonpathogenic. The principal species is the *lactic acid bacteria.* If the milk can be kept cool, these bacteria are held so completely in abeyance that they will not cause a souring of the milk for several days. If the temperature, however, is allowed to rise much above fifty degrees the bacteria will begin a rapid multiplication, and as these bacteria consume milk sugar, and throw out as a waste product lactic acid, they will cause the milk to sour. This souring of the milk would take place within a few hours after the milk is drawn if it were kept at body temperature.

A thorough inspection of the milk is not complete until the number of bacteria in a unit volume of the milk is determined. When this number passes a certain standard minimum it is accepted as evidence that the milk has not been properly cared for. In this connection, it may be stated that among other elements

in the care of milk should be the thorough cleaning of all receptacles and containers. Not only should milk pails, milk cans, milk bottles, and other utensils that come in contact with milk be thoroughly washed in hot soapsuds, but they should be thoroughly scalded in hot water after the washing. Only by taking all of these precautions can the milk be kept pure.

The reason for all these precautions is that milk is a specially fine culture medium for bacteria in general. Many forms of bacteria thrive in milk, not only those forms already mentioned, but, unfortunately, certain disease germs also. Sanitarians have traced the spread of such diseases as typhoid fever, diphtheria, tuberculosis, and scarlet fever to contaminated milk. It is not uncommon, for example, for milk to become contaminated with typhoid-fever germs in the following manner: There is a case of typhoid fever in the family of a dairyman. The excreta from the patient, instead of being thoroughly destroyed or disinfected, are emptied into a vault or outdoor water-closet. Seepage from this closet bears typhoid germs to a near-by barn well. The dairyman rinses his milk cans from the water in this barn well, the cans become infected, the germs propagate rapidly in the milk, and may be distributed over a wide district. Perhaps a more common way of distributing typhoid-fever germs from the sick room to the milk cans is through the agency of flies. If a fly walks over any of the excreta from the patient either in the sick room or at any time before it is disinfected he may carry away on his hirsute surface thousands of bacteria. If he lights upon the rim of a just filled milk can to take a meal from a drop of milk that has accidentally gathered there, he may infect the drop which remains to dry upon the rim of the can, and infect the contents of the can as the milk is poured out. Tubercular contamination of milk may be direct from tuberculous cows, or from dust bearing tuberculous germs. Without doubt, the dissemination of disease was very general and widespread through the milk supply before the general interest in sanitation. At the present time, however, inspection of milk and of dairies and the general dissemination of information among dairymen and milk dealers as to sources of contamination and methods of avoiding such contamination have resulted in a very great improvement of conditions, so that one

has not much to fear in the use of the milk from the reputable dealers.

Incident to the souring of the milk, the casein is coagulated into a delicately gelatinous mass similar in consistency to an egg-milk custard. Milk in this condition is called clabber. After a few hours there seems to be a moderate contraction of the coagulum because there is a division of the coagulum from the yellowish whey. If the clabber is heated slightly this contraction of the coagulum becomes very readily apparent, and there is a fairly complete separation of whey from curds. In this separation the cream and most of the lactalbumin are entangled with and held with the curd, while the milk sugar and milk salts, together with a possible trace of the albumin, are separated out into whey. Cheese is made from the curd. Whey is usually fed to the pigs. The simplest cheese is the cottage cheese, or schmierkäse, made by every housewife. The varieties of cheese found in the market represent various processes of pressing and curing, the almost innumerable variety, owing their differences in part to the proportion of casein and fat, and in part to the conditions under which the cheese is cured; the finest grades of cheese possessing the most delicate flavor being cured in cooler climates and higher altitudes.

The coagulation or thickening of milk, as described above, is typical of that produced by lactic acid. Casein of the milk may, however, be coagulated by any vegetable, fruit, or mineral acid. Hydrochloric acid, for example, causes a very rapid coagulation even when that acid is so dilute as a tenth of one per cent. In this strength the hydrochloric acid of the stomach causes a coagulation of the milk. The curds formed through the influence of the stronger acids, as hydrochloric acid, for example, are much tougher and more leathery than are the curds formed through the influence of lactic acid. This has a direct bearing upon the use of milk in the sick room, because the curds produced by hydrochloric acid are not easily digested by a delicate and sensitive stomach. For that reason it is common to modify the milk used by invalids. The simplest modification is the skimming of the milk that removes a large part of the fat and makes the milk somewhat more easily digested. Boiling also renders the milk

more easily digestible, partly through the removal of the lactalbumin which is separated out on boiling, and rises on the surface of the milk in a thin crinkly membrane. The casein is also somewhat modified by boiling, so that it coagulates in the stomach in small flakes instead of large curdy masses. Whole milk may be diluted with limewater, which modification is brought about by adding to milk about an eighth to a sixth of its volume of limewater. Barley water and oatmeal water are also sometimes added, which additions seem to prevent the formation of leathery curds, and thus increase the digestibility of the milk.

In the digestion of milk in the stomach of the infant, in common with all mammalian young, the milk is curdled not through the agency of acids, but through a milk-curdling ferment called rennin. Rennin or rennet extracted from the stomach of young mammals, for example, from the stomachs of the veal and young pigs slaughtered for market, is used for curdling milk in the cheese-making process. The great advantage of using this agent for separating the curds from the whey, is that the resulting curd is not sour, as is the case when the coagulation is caused by acid. Another use of rennet is in the junket tablets which are used in the preparation of the dainty milk custard called junket, which is nothing more than coagulated whole milk flavored with some such flavor as vanilla.

Condensed milk is a preparation made by evaporating the water of the milk in a vacuum. The milk thus reduced to about one fourth of its original bulk and sterilized incident to the process, placed in hermetically sealed cans, may be kept indefinitely without decomposition taking place. In this form milk is convenient for use in camps, on journeys or voyages, or in any situation where fresh milk is not available. Undiluted, it serves as a palatable substitute for fresh cream in coffee. Diluted with three or four volumes of water it may be used in cooking the same as fresh milk. As a beverage it is not palatable to most people because of a modification of its flavor.

Mention was made above of the wide use of eggs in composite preparations, such as custards, cakes, muffins, etc. Even more widely used than eggs in composite foods is milk. It is almost

universally used wherever eggs are used with such foods, and in many places where eggs are not used, as, for example, in the liquid element of bread sponge already mentioned above. This prevalent use of milk in composite foods is to be heartily recommended, because milk is in itself a perfect and complete food, and naturally increases the nourishing properties of all composite foods of which it is an ingredient.

D. FOOD ACCESSORIES

There are many substances which are taken with the food and which influence considerably the processes of nutrition, but which are not foods.

These substances are called food accessories, and may be classified as follows:

1. **Beverages.**—Beverages are drinks which represent extracts, aqueous solutions, or aqueous dilutions of various organic, usually vegetable, products. The most common example of beverages are: Tea, coffee, cocoa, chocolate, lemonade, and allied drinks. They serve to *relieve thirst*, and they may in addition serve *as nutrients, as diuretics, as diaphoretics, or as stimulants.*

Tea.—Tea is a decoction made from the leaves of a shrub that grows in southern and eastern Asia and the neighboring islands. While there are many varieties of tea on the market, they do not differ essentially one from the other from a dietetic standpoint. The active principle of the tea is *thein*, which is identical chemically with caffein extracted from coffee. Tea is usually prepared by pouring boiling water over the dried leaves, allowing it to stand a few minutes. The decoction thus quickly made has either a light yellowish or greenish-yellow color, or a darker brownish-yellow color. The lighter color is found in the China and Japan teas, while the darker color is usually found in the teas from India and Ceylon. In the preparation of tea the leaves should never be actively boiled, as that process rapidly extracts tannin from the leaves. The addition of tannin to a drink used habitually eventually disturbs digestion, and it is likely also to lead to constipation. Furthermore, the tea made

as suggested above possesses a far more delicate aroma than tea made by boiling, as the boiling drives off the aroma. Tea is a stimulant; the stronger the drink is made the more marked its stimulating effect. Some people respond more quickly and fully to the stimulation of tea than do others.

Coffee.—This beverage is prepared from the seeds of the coffee berry. The coffee tree grows in many tropical and subtropical climates, and is said to have been used thousands of years ago by the inhabitants of the Arabian peninsula. The real Mocha coffee is produced in the oases in the region of the city of Mocha. Java and Rio coffee comes from the island of Java and the city of Rio de Janeiro. A high grade of coffee is produced in the highlands of Mexico. It possesses a flavor so nearly like the Mocha that it is widely used as a substitute for Mocha in blends. While various varieties of coffee, produced as they are under varying climatic conditions, possess distinctive flavors, they do not from a dietetic standpoint present any essential difference. The active principle of coffee is caffein, which is an alkaloid that acts as a strong stimulus to the central nervous system. Through this stimulating action not only are psychical activities noticeably increased for a time, but many of the physical activities are also increased. For example, the heart action is considerably increased in rate as well as in strength. As a result of this, blood-pressure is noticeably and markedly increased. This in turn leads to an increase of kidney action. So strong coffee as well as strong tea are likely to be followed by a noticeable increase in kidney activity, they are diuretic.

Cocoa and Chocolate.—These beverages are prepared from the cocoa bean. The cocoa from the meaty shell of the bean and the chocolate from the rich kernel of the bean. The chocolate differs from the cocoa particularly in the fat which it contains. The oil of chocolate is oleum theobromin, and does not belong to the food fats, being much simpler in constitution and not capable of deposit as a food reserve in animal tissues. The active principle of cocoa and chocolate is *theobromin,* which is closely allied to caffein, though simpler in construction, and has a mild stimulating effect on the nervous system. Besides its use as a beverage, chocolate is widely used as a confection. Its use in this form is greatly

increasing and extending, while cocoa is in a measure displacing the chocolate as a beverage.

Lemonade.—Lemonade is cited and may be taken as an example of a long list of fruit drinks, or beverages flavored with fruit juices. These beverages are very pleasing summer drinks because they are fairly effective in slaking thirst. Some of them, particularly drinks made from the citrus fruits, as lemonade, orangeade, and many varieties of these two, possess besides their thirst-slaking qualities a distinct diuretic and diaphoretic action, and may be given freely in order to produce such action.

Many food drinks are carbonized—that is, they are bottled for use in sealed bottles, and incident to the bottling process there is forced into each bottle a quantity of carbon-dioxid gas under pressure. As soon as the stopper is loosened the gas begins immediately to escape. Such effervescent drinks seem to possess some advantage as slakers of thirst; but for this purpose no beverage ever devised by man can excel plain water.

Root beer is a drink flavored with various barks and roots, and when gotten at a soda fountain, or in bottles put up at a bottling factory and carbonated, possesses no deleterious ingredients, and is a pleasing soft drink. When this drink is prepared in the home, and in accordance with the recipe given on the package, it contains between one and three per cent of ethyl alcohol, whose presence is due to the action of the yeast which is used in the preparation of the beer. As to the advisability of introducing into the home for family consumption a beer containing one per cent to three per cent of alcohol an overwhelming majority of people will agree that the free use of such a drink would be ill advised.

2. **Condiments** are substances added to food to give it a flavor or to modify its flavor. Examples are: Pepper, nutmeg, cinnamon, cloves, allspice, sage, thyme, mustard, ginger, mace, horseradish, vanilla, dill, etc. The active principle in each of these is a volatile oil peculiar to the substance. These volatile oils have no importance as foods, but they serve as stimulants to the buccal mucous membrane, and in that way frequently serve a good purpose in inciting an increased flow of the digestive juices.

Common salt, though usually spoken of as a condiment, is,

strictly speaking, a food, and is necessary to the animal body, as one of the mineral salts used in the tissues and fluids of the body. However, the amount of salt used by many people is far in excess of the needs of the body. When salt is thus used in excess of the needs of the body, and used simply to modify the taste of the food, the excess so introduced into the dietary becomes a food accessory.

Though the condiments possess this mild stimulative effect upon the tissues with which they come into contact, it is very doubtful if, on strictly physiological grounds, their use is justifiable. This thing is certainly true: young children should never be given highly spiced foods; in fact, it is probably wiser to give them no spices. Appetites for these condiments are artificial and acquired ones. A person who has acquired an appetite for condiments may be unable to relish his food without these. That being the case, the condiment becomes more or less of a physiological necessity to such person. However, if from early childhood an individual receives no condiments in his food, he learns to relish them for their own natural flavors. In such a person the use of condiments is altogether unnecessary if not actually disadvantageous.

3. **Intoxicants** are beverages, such as a cider, beer, ale, wine, brandy, etc., the active principle of which is ethyl alcohol. Ethyl alcohol possesses several characteristics in common with the carbonaceous foods—e. g., (1) it is composed of C, H, and O; (2) it is readily oxidized in the liver, yielding CO_2 and H_2O, which are excreted; (3) it yields heat incident to its oxidation, and this heat naturally augments the body income of heat; (4) ingestion of ethyl alcohol leads to a decrease in the catabolism of carbonaceous foods, and may even "spare" proteins.

In this connection one must not lose sight of the following facts:

1. All vegetable toxins and alkaloids are composed of the same kind of chemical elements as enter into foodstuffs—viz., C, H, O, and N.

2. Toxins and alkaloidal poisons in general are oxidized in the liver through the agency of oxidases, whose function is to oxidize, and thus make harmless substances which would act as

protoplasmic poisons on all cells with which they come into contact. When moderate amounts of such toxins are taken the defenses of the system are sufficient to reduce them to a harmless condition, and no immediate injury results. If larger quantities are ingested the full drug effect (narcotic in the case of alcohol) is immediately experienced, the oxidases of the system being unable to defend it against a large dose.

3. All oxidation yields heat, whether it is a normal catabolism or a protective oxidation. That the heat from the oxidation of alcohol is not a normal catabolism for the purpose of heat liberation is evident from the fact that, notwithstanding the liberation of heat on oxidation of alcohol, the temperature of the body falls, because of increased loss of heat from the surface. This increased loss is due to dilatation of the peripheral vessels.

4. Decreased catabolism of carbonaceous or nitrogenous foods following ingestion of a narcotic is a universal fact, depending upon the drug effect and giving to the oxidized narcotic no significance as a food. It may be said without reservation that ethyl alcohol is not a food in the full scientific significance of the word.

Intoxicants can, therefore, have no rational place in the menu or among the beverages of a normal healthy individual. Of its use as a drug adjuvant to various food preparations in the sick room more will be said in a subsequent chapter.

CHAPTER IV

THE PREPARATION OF FOODS

A. THE CARE OF PERISHABLE FOODS

Under this head it is proposed briefly to discuss the immediate care in the kitchen of these perishable foods. Preservation of perishable foods, such as meats and fruits for use at some future time, will be discussed in detail under the heading "Food Preservation." The perishable foods are those which quickly deteriorate and become inedible because of decay, various forms of fermentation, or in the case of crisp garden vegetables, wilting and drying. No rational and consistent régime for reducing this decay of perishable foods can be devised without a knowledge of the causes at work to bring about the decay. Decay and fermentation are caused by bacterial action. The souring of milk, as discussed in the preceding chapter, is a bacterial action. Rancidity of butter, decay of fruits and vegetables, are likewise in each case the work of a microörganism. These microörganisms usually produce spores or minute dust-like particles in one phase of their life history. These dust-like spores readily find lodgment in kitchens, to be easily stirred up and settle upon the fresh-food products brought into the cellar or kitchen, and start the process of decay or fermentation in these. It goes without saying that the first step in kitchen and cellar sanitation with a view to the easy preservation of perishable foods is a complete renovation and cleaning of these parts of the house in which foods are kept. A cellar should not only be absolutely freed of its dust, but to be well adapted for the preservation of fresh fruits, vegetables, milk, and meat, it should be *clean, cool, dry, and dark.* Sometimes the conditions are such that it is impossible to produce all of the last three

requisites of a good food cellar, but there can hardly be conditions where anything short of perfect cleanliness is excusable. All four of these requisites of a good cellar tend to inhibit, if not actually to stop, bacterial growth. If it is possible to do so, the fruit and vegetables should be kept separate from the meat and milk, because of the tendency of milk particularly to take up odors from vegetables.

In most urban homes and in some rural homes the refrigerator, cooled by ice, takes the place largely of the cellar. The refrigerator, though small and compact and artificial, may possess all of the qualities above mentioned for the cellar, and the first of all these qualities should be absolute cleanliness. Care should also be taken not to keep milk in open crocks, exposed to such vegetables as turnips, cabbage, or onions, because of the readiness with which the milk takes up the odor from vegetables.

The old-fashioned custom of keeping a garbage pail of several gallons' capacity in or about the kitchen to receive waste bits of food has in the modern kitchen sanitation been relegated to the scrap heap. No such scraps of food, waste food materials, should be permitted to accumulate even from one meal to another, but they should be transported outside of the building entirely.

A most important thing to observe in kitchen and dining-room sanitation is the protection of these rooms against flies. In the times of our fathers flies were looked upon as necessary evils, and people made the best of them. If cheese and ham and other similar meat products became infested with maggots (the larvæ of flies), this condition was hardly looked upon as being more than an annoyance, no thought apparently being entertained of making such a condition impossible. Modern sanitation, however, recognizes in the fly a most perilous parasite. Typhoid fever and several other dangerous diseases are transmitted from house to house by flies. If the nurse in charge of a typhoid-fever patient is careless in her duties, excreta from the patient may be exposed for many minutes, perhaps hours, before it is disinfected, during which interim it may be visited by flies, their hairy feet may become loaded with typhoid bacilli, after which they leave the house for an excursion in the warm sunshine, to be attracted by savory smells from a near-by kitchen, to light upon the screen

door, and to seek an opportunity to gain entrance to the kitchen; having found the opportunity, they pass in perhaps just in time to walk around over the just served dinner of the host. A week or ten days later some member of this neighbor's family comes down with typhoid fever, and people wonder why Providence has visited two families in the same neighborhood with this dreaded disease.

B. FOOD PRESERVATION

Under this head we will discuss the methods of preparing perishable foods so they may be preserved for an indefinite length of time. Fruits which are in season only a few weeks during the year may, if properly preserved, be served at any time during the whole twelve months. The same is true of all the vegetables and meats, milk, butter, and even eggs. The essential condition for processes of decay to proceed are warmth, moisture, access of air. Reduction of temperature to near the freezing point stops all bacterial action. Removal of moisture also stops it; shutting out the air from substances already sterile will preserve them from decay. One of the simplest methods of food preservation is cold storage. This method carried on on such a large scale in the great population centers enables dealers to keep meats, butter, eggs, and certain fruits for many weeks, perhaps even months. While there is a certain amount of deterioration continually going on, which would eventually make the preserved food inedible and unwholesome, still the process, while it has limitations, is a most valuable one, and results in the preservation and use of millions of dollars' worth of food supplies which would otherwise have to be thrown away after having glutted the season's market. This cold-storage process facilitates a distribution of food products usually marketed in a season of limited length over a very much longer period of time, thus in a large measure equalizing the price of the food through the year. Cold storage is a process for the large dealer. Let us turn our attention now to processes that may be utilized in the home and in institutions, though they are also utilized on a large scale by producers and dealers. One of the simplest processes for food preservation is

drying it. As revealed in the analytical tables given above, a very considerable proportion of all perishable foods is water. In fact, in some of these foods water makes as much as ninety per cent of the weight. If we can remove all or nearly all of the water, we will not only inhibit bacterial action, thus preserving the food for an indefinite time, but will also reduce the food greatly in volume and in weight, thus facilitating its easy storage and transportation.

In the earliest times fruits were dried. Those fruits rich in sugar are especially adapted to this process, and it is probable that the drying and storing of figs and dates has been followed for unnumbered ages in the Orient. Meats have been cured by drying by most primitive peoples. The only requisite to be observed in the drying of meat is to keep the flies away. This is accomplished by some Indians through tying strips of the meat to branches of trees twenty or thirty feet above the ground, thus out of the fly zone. In the drying of the meat it is customary to add some salt, this acting as a further preserving agent. Another modification frequently observed for meats, including fish, is smoking. The meat to be preserved is smoked over a smoldering fire. The heat of the fire dries the meat; the smoke flavors it. This smoked meat and fish possesses a flavor very pleasing to most people.

The drying of fruits and vegetables by removing so much water from the pulp of the fruit or vegetable makes it not only light and dry, but hard and unpalatable. In the preparation of such dried fruits and vegetables for the table it is necessary to introduce the water back into the tissues. This is best accomplished through soaking in cold water. Time should be given for the tissue gradually to take up the water and swell out to nearly its original size. After being thus soaked, the fruit or vegetable may be very quickly prepared for the table.

Treatment of perishable foods with various chemicals is another favorite method of preserving them. So far as possible, the substance used as the preservative should be a substance which is in itself either food or a recognized condiment. As an example of the first, sugar may be mentioned. Sugar solutions that are very heavy and syrupy do not readily ferment. Mold may collect upon the surface, but ordinary sugar fermentation cannot

take place. Thus sugar came to be used very widely as a food preservative, especially for fruits. Jellies, jams, and preserves are examples of such products. When a small amount of sugar only is added, it is necessary also, in order to insure preservation against fermentation, to exclude the air from the preparation. This method is very widely used in modern times in the preservation of fruits and vegetables in tin and glass cans. In many of these canning processes only a very slight amount of sugar is added, perhaps in the case of some vegetables none at all. In this case the preservation is due simply to the exclusion of air from the sterile products, sterilization being an absolutely essential preliminary.

Another preservative widely used is common salt. While salt is a condiment widely used, there is a limit to the amount of it that is wholesome. Its use as a food preservative far exceeds the amount that is palatable in the food in question. It, therefore, becomes necessary in the preparation of salted meats and fish to remove a large part of the added salts as a preliminary, thus the method of removing this excess of salt is by soaking in cold water for a time. In the case of a salt fish, it may well be soaked ten or twelve hours, as overnight.

Another condiment widely used in the preservation of food and vegetables is vinegar. Vinegar as used in the kitchen is four per cent acetic acid, plus a minute proportion of extractives that give it flavor. When a vegetable or fruit is impregnated with vinegar, it may be kept for months without decaying or fermenting. In this way many varieties of pickles are prepared—both fruit and vegetable pickles. The addition of various spices in varying amounts and combinations, with or without sugar, in varying proportions, makes up an interminable list of fruit and vegetable pickles.

Antiseptic preservatives, such as salicylic acid, formaldehyd, boric acid, alum, sulphur, sulphur vapor, and benzoate of soda, have been used in attempts to preserve food materials for the market. Their use is most frequent in milk of the city markets and in canned meats and fruits.

While minute quantities of certain of these things, particularly of benzoate of soda, borax, boric acid, and sulphur, produce no

disturbance of the normal functions, even when taken daily for months, still, it is very greatly doubted whether their use in any proportion should be permitted in the supplies of food presented in the markets. The contention made by Dr. Wiley, of the United States Department of Agriculture, that "the use of any of these preservatives, if permitted at all, is likely to be used by unscrupulous producers to make marketable food products that without such antiseptic agents could not be preserved," while very conservative, marks perhaps, in the long run, the wisest course to pursue. This thing is true, that food products in which decay has not already started may be easily preserved by methods given above, from beginning decay, and the use of these chemical antiseptics should not be necessary. On the other hand, it has also been conclusively demonstrated by a commission of Government experts that the use of a small amount of benzoate of soda may serve a valuable purpose in the preservation of fruit and vegetables by furnishing an added and final security against incipient fermentation, while, at the same time, this substance in particular is not deleterious when taken in the small quantities incident to its use in these materials as a food preservative.

C. ARTIFICIAL FOOD PREPARATIONS

A volume might be written in description of the unending list of patent and proprietary food preparations. Many, perhaps most all, of these are prepared with the sincere desire and earnest attempt to furnish a needed and valuable article. Many of the products have accomplished this to a greater or less degree. Some of the proprietary foods possess great value. Others possess a little value. Even an enumeration of these foods in the preparation of a brief manual may be properly omitted. A few general principles may be formulated as a sort of guide regarding such preparations in general.

I. Chemical Analysis Not Conclusive.—A common fallacy which has deceived not only the producers and dealers, but also physicians and dietitians, is that a food whose chemical analysis shows that it contains proteins, fat, carbohydrates and salts in

the proportions approximating those in which these foodstuffs exist in some common wholesome food should be equally nourishing and wholesome. It must be admitted that it does not infrequently occur that such a patent and proprietary preparation is well borne by an infant or an invalid as the case may be, and seems to, and perhaps does, supply the nutritional needs of the body. On the other hand, a large proportion of individuals find the flavor of the preparation unpleasing and find that if they eat it at all it is taken under protest and does not seem to agree with them. It will not fulfill the nutritional requirements of their bodies. Chemically, the food is all right. Physiologically, it is faulty and cannot be continued without marked disturbance of nutrition of the individual.

II. Predigestion Unnatural.—A large number of the proprietary foods, patent foods, and widely advertised breakfast foods are partly predigested. Proteins having been reduced to proteoses and peptone, starches having been reduced to dextrins and sugars. Such predigested foods or portions of foods are naturally quickly dissolved and readily absorbed. The fact that they are predigested does not interfere with their action in the body once they are absorbed. The difficulty with predigested food must be sought in another direction. *It does not stimulate the action of the digestive glands.* The work of these glands having been already accomplished, they rest; their inactivities become habitual if the use of the predigested food is long continued. In this way a sluggishness of the digestive system may be gradually induced which will require weeks or even months to correct. Predigested food is as bad for digestive glands as presawed wood is to muscles. If a father saws the wood that his boy should saw, thus relieving the boy's muscles from vigorous activity, these muscles will become flabby and weak. Similarly, if a father gives his boy predigested food, the glands, relieved of the necessity of doing any work, become inactive and weak. The principle, therefore, that is involved is a far-reaching biological principle, whose application is as broad as are the manifestations of plant and animal life on the earth. *Unused functions become sluggish and weakened; nonfunctioning tissues become flabby and atrophied.*

Predigested food, as peptonated milk and starch reduced to

sugar and dextrins, may properly be used temporarily to tide over a nutritional crisis. Their use, however, should be discontinued at the earliest possible moment.

III. Liquid and Pulpy Preparations.—Liquid and pulpy preparations should make only a very small proportion of the diet of a healthy person after the second year, for a reason similar to that just cited above. These liquid and pulpy foods might be called prechewed foods. After an individual gets teeth he must use them if he would keep them. While liquid and pulpy foods may be introduced into a menu, they should not make up the whole menu, except in the case of infants and invalids. In an infant dietary solid foods should be introduced as soon as the child has developed an armament of teeth with which he can chew. In the case of the invalid solid foods should be used as soon as the temporary condition has passed, which necessitated their abandonment in favor of the liquid and semi-liquid foods.

D. COOKING

While fruits, nuts, and some vegetables may be and are eaten raw, man has from early times cooked meats and cereals. The cereals were first probably parched among the coals. Primitive peoples barbecued their animals over heaps of coals, or roasted over the coals pieces of flesh cut or torn from the big game. Small animals were roasted, sometimes over the coals, sometimes incased in mud and baked in the hot ashes.

Cooking serves several important purposes; among the most important is the development of pleasing flavors. It is not unlikely that among primitive peoples this was the sole reason for cooking. We recognize now, in the light of modern study, that a further important advantage is gained—namely, the sterilization of the cooked foods, thus killing all parasites and microörganisms. A further important end gained in cooking is to make the food more easily or more completely digestible. The cooking of meat makes the connective tissues more tender and digestible by partially or wholly gelatinizing them, thus making what may have been a tough piece of meat only partially digestible and exceedingly difficult

of mastication, easily masticated, pleasing in flavor, and readily and completely digestible. In a similar way cellulose portions of vegetables, fruits, and cereals are broken up and softened, *making the food more easily masticated, more pleasing in flavor, and more readily digestible.*

Certain principles should govern the cooking of foods.

I. Heat and Moisture Essential.—As indicated in the preceding paragraph, the connective tissues of cereals, vegetables, and meats—that is, the cellulose of cereals and vegetables and the collagen of meat—can only be made tender, presentable and palatable by the combined action of heat and moisture for a considerable period of time. The time varies from thirty minutes or an hour in the case of some vegetables, to several hours in the case of other vegetables, and of those meats in which connective tissue makes a large proportion.

II. Extraction Versus Retention.—A second fundamental principle to be observed in cooking is that which concerns the juices of the food to be cooked.

To extract these juices as in the preparation of vegetable soups, and meat bouillons, broths, and soups, it is necessary to immerse the material in cold water, bring the substance very slowly to the simmering point, at which point it should be kept for a number of hours. This results in a gradual extraction of the flavors of the food. Various modifications of this general process need not be here described. It is enough to say that the clear soups, broths, and extracts thus prepared, while possessing little nutriment, possess the delicate and delicious flavor of the vegetable or meat and are, therefore, appetizing introductions to a meal. All such clear broths, bouillons, or soups are, however, almost completely lacking in nourishment and exert their influence as a direct stimulation to activities of the gastric glands. Incident to the preparation of these broths, bouillons, and soups, the vegetable or meat "stock" is thoroughly cooked and the cellulose of the vegetable made tender, and the collagen of the connective tissue gelatinized. A very common variation of these preparations is to leave considerable portions of vegetables or meats in the soup, sometimes even adding such other food elements as boiled rice, barley, egg, etc.

Retention of the juices of these foods that are to be subjected to boiling is accomplished by plunging them at once into boiling water. This coagulates the surface proteins which, especially in the case of meat, locks up the juices to a large extent within the body of the meat. In the cooking of meats particularly, retention of the juices is more readily accomplished when the meat is broiled, roasted or baked, as the dry heat of the grill or of the oven when the meat is subjected from the first to high temperature, sears the surface of the meat into a sort of crust which effectually retains the juices.

METHODS OF COOKING

Methods of cooking discussed in the light of the above general principles:

I. **Boiling.**—In boiling the moisture is unlimited, but the heat is limited to the boiling point of water, which at standard atmospheric pressure is 212° F. (100 degrees centigrade). This temperature is not sufficient to cook some foods right without the time being extended over a considerable period. Boiling is quite impracticable in high altitudes because the boiling point of water is enough lower in these altitudes so that the foods which ordinarily may be boiled sufficiently in thirty or forty minutes would, at the high altitudes, require a greatly prolonged period. Boiling of meat, even when the meat is cut into small pieces and plunged into boiling water, results in a considerable extraction of juices. However, this is a matter of no disadvantage in many cases, and the juices thus extracted may be utilized for the making of rich and palatable gravies which, served with the meat, restore to it the original juices externally applied. In the preparation of the German pot roast, for example, extracted juices are in part taken up by the roast as it is "boiled down in the pot."

II. **Roasting and Baking.**—There is no essential difference between roasting and baking, as both are performed in an oven heated to several hundred degrees. The term "baking" is more generally applied to the process as applied to breads, pastries, etc., while the term "roasting" is more generally used when the process is applied to meats. The reason for this probably dates back to the time when breads, pastries, etc., were baked in ovens

or pans in the coal and ashes of an open fireplace, while meats were roasted on a turning spit over the coals. When the modern stove or range with its oven was introduced, the old terms " baking " and " roasting " were continued, notwithstanding the fact that the bread was baked and the meat roasted in the same oven, under the same general conditions. In passing, the author would emphasize the importance of " basting " a roast. While the juices of meat are in a large measure sufficient in their moisture to assure a gelatinization of the connective tissues of the meat, especially when the baking is continued at a moderate temperature and for a longer period, still, this gelatinization of the connective tissues is produced much more quickly and completely if the roasting meat is frequently basted. Various basting liquids have been devised, but the most practical and effective one is the liquid which may be dipped from the pan in which the roast rests. This is simply a mixture of melted fat, water, and meat juices, together with any savory spices or mints that may have been used in the dressing, the essential constituent always being the water. A self-basting device has been made in which a cover over the roasting pan collects the evaporated moisture, conducts it to a point over the roast where it drips upon the roast. In this case the basting liquid is naturally nearly pure water. While this method is a labor-saving device, it is doubtful if it produces as good results as a hand basting with the mixed liquor from the roasting pan.

III. Frying.—Two methods of frying are in general use. First, fritters, doughnuts, Saratoga chips, French fried potatoes, and some other preparations are fried by floating them in boiling hot fat. This hot fat reaches a temperature of 400° to 600° F., which is so much hotter than the temperature of boiling water that the food is rapidly cooked, the immersion in the hot fat usually lasting but a few minutes. The effect of the hot fat upon the food is to sear or coagulate the surface, making a sort of coating which protects the inside from absorbing the fat. Foods thus prepared may be savory and wholesome, and there is no essential objection to this method on physiological grounds.

The other method of frying is simply to put a film of grease in an open frying pan and put potatoes, French toast, griddle

cakes, eggs, and corn-meal mush upon this film of hot fat. There are two disadvantages to this method. First, the volume of fat is so small that it is very likely to become superheated. This point can be detected by the smoking of the fat. Smoking fat is rapidly volatilizing; if a lighted match were brought into the column of smoke, it would burst into flame, showing that the fat is being reduced to a vapor. The remnant of fat still left in the frying pan rapidly turns brown and has a strong acrid taste due to the liberation of fatty acids and perhaps other products of combustion. The food which is frying in the pan takes up a certain amount of this brownish, acrid fat, and besides being far less palatable, the food is, partly for that reason and partly because of its having soaked up fat, much more difficult of digestion than if prepared by other methods. The success of this latter method of frying, if it is to be used at all, rests upon the skill and close attention of the cook, who should never permit the frying pan to smoke.

PART TWO

THE USE OF FOODS IN THE BODY

CHAPTER V

THE DIGESTION OF FOOD

It is proposed in this chapter to describe briefly the processes of digestion. It is assumed that the reader is well acquainted with the structure of the digestive system, including a knowledge of the mucous lining of the alimentary canal throughout, and of the tributary digestive glands such as the salivary glands of the mouth; the gastric glands of the stomach wall; the pancreatic gland that lies behind the stomach and pours its secretion into the duodenum, and the liver, the largest glandular structure in the body, which occupies the upper right-hand portion of the abdominal cavity and pours its secretion, the bile, into the duodenum; the intestinal glands situated deeply in the walls of the small intestine, and the mucous glands of the large intestine. It is expected further that he is acquainted with the musculature of the walls of the alimentary canal, and the location of the sphincter muscles of cardia, pylorus, and anus. He is further expected to know the circulation of these parts of the digestive system, its immediate source and how it is distributed, also the innervation and the factors which influence through the nerves the muscular movements and secretory activities of the alimentary canal and its tributary glands. With this knowledge well in hand, we may proceed with a brief but sufficiently full consideration of the physiological processes of digestion.

It will be found that the knowledge of foodstuffs and foods, as set forth in the preceding chapters of this work, will be of the greatest assistance in understanding not only the nature of the digestive processes but their significance and their relation to general life processes, including nutrition.

A. SALIVARY DIGESTION

This term is applied to that part of the general digestive process brought about by the saliva or the secretion of the salivary glands of the mouth. This process naturally begins in the mouth, but it does not end with the passage of the food out of the mouth cavity. It continues in the stomach until the accumulation of acid gastric juice has reached such a point as to cause a marked acidity of the general stomach contents. The saliva on chemical analysis is shown to consist of about ninety-nine and a half per cent water, one half per cent solids. Among the solids the most important one is the enzyme or ferment ptyalin, which is the active digestive factor of the saliva. Other substances found among the solids are sodium chlorid, sodium carbonate, mucus, epithelium. Of these the last named is purely incidental and the mucus serves an important purpose in lubricating the masticated food; the sodium carbonate serves to insure the alkalinity of the mass. It is present in such small quantities that the saliva shows this reaction very faintly. Sodium chlorid is a constituent of all the body secretions. While the saliva is secreted more or less continuously into the mouth cavity, its secretion is very much more copious when food is being masticated. At other times the evident purpose of the saliva is to keep the mucous membranes of the mouth cavity moist.

The introduction of foods into the mouth is accompanied by a more or less profuse secretion of the saliva as the mastication proceeds. The sight or smell of savory foods may create an increased flow of saliva; even the thought of such food frequently causes the mouth to "water." This flow of saliva in response to the thought, sight, smell, or taste of food is accomplished through the agency of the nervous system. The nerves of the salivary glands, having their origin in the medulla, bring messages from the central nervous system to the glands, causing them to increase their secretion in response to these various sensory impressions received. The amount of the salivary secretions is strongly modified by the appetite, as it is the appetizing foods or even the thought of some much-relished food which causes the mouth to water. The stronger the relish for food the more profuse the se-

cretion; the longer the appetizing morsels are held in the mouth and enjoyed, as they are masticated, the finer will be the division of food—that is, the more perfect the mastication and mixture with

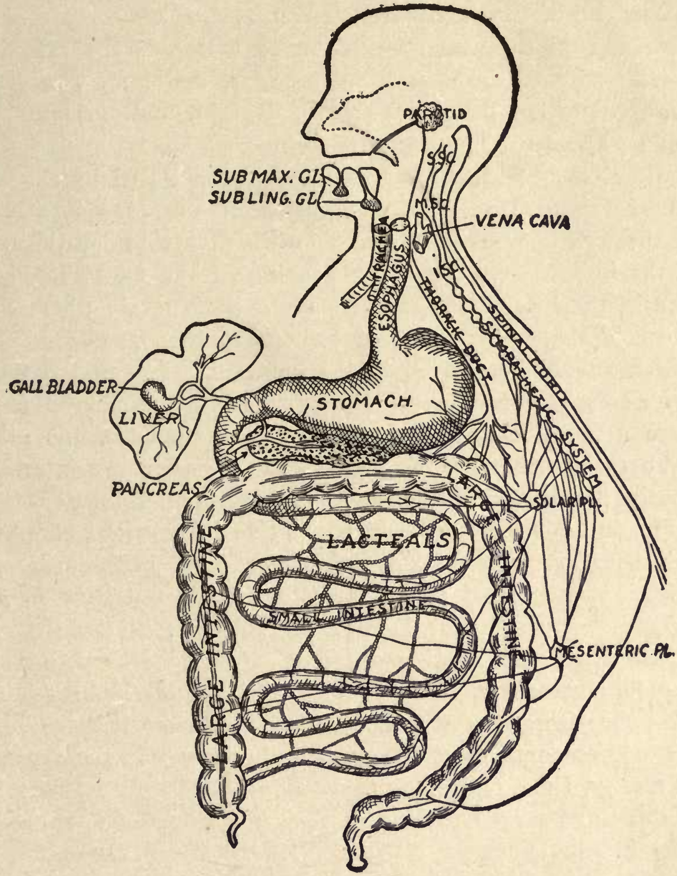

Fig. 3.—Diagram of the Digestive System.
Showing alimentary canal, associated glands, lacteals, and nerves.

saliva, the more perfect will be the first step in the general process of digestion.

This first step in the general process of digestion is produced by the ptyalin of the saliva, and consists in the digestion of the

starches. The carbohydrates are the only foods whose digestion begins in the mouth. The sugars are simply dissolved in the water of the saliva. The starches are the only foods which undergo a chemical change in the mouth. This chemical change consists in the breaking up of complex starch molecules into less complex dextrin molecules as the first step. The next step is the breaking up of dextrins into the still simpler sugar, maltose. The steps of salivary digestion then are: starch, dextrin, maltose; and *the end product of salivary digestion is maltose.*

All digestive processes are very greatly facilitated by the fine division of the food. This fine division of the food is accomplished through two processes, both of which are under the control of the individual. First, the cooking of the food should be thorough in the case of starchy foods and those meats which contain a considerable proportion of connective tissue. Second, the mastication should be carried to the point of reducing the foods to smooth creamy consistency. However, while the starchy foods alone are actually changed chemically in the mouth, the other food preparations that are digested in the stomach and intestines are greatly hastened in digestion by this complete mastication. Frequent emphasis has been put upon this in previous chapters, yet it is so all-important that the writer feels justified in emphasizing it as the most essential factor in the nutrition of the body. It is important, first, because it greatly facilitates the rate and thoroughness of digestion of all the foods. Second, because it forestalls overeating, thus protecting the individual against headache, sluggishness, and accumulation of adipose tissue. Third, through food economy, there is saving and economy in the expenditure of money, time, and energy.

B. GASTRIC DIGESTION

Gastric digestion is so called because it takes place in the stomach under the influence of the gastric juice. Gastric juice consists of ninety-nine and a half per cent water, one half per cent solids. Essential among the solids are the enzymes (pepsin and rennin), hydrochloric acid, and mucus; the latter serves in

part for the lubrication and in part as a protection to the mucous membrance against the digestion of its own substance. The constituents which bring about the chemical change of gastric digestion are the acids and the enzymes, particularly the pepsin. Gastric juice begins to be secreted into the stomach soon after eating begins, but it does not for some time (varying under different conditions from twenty or thirty minutes to three quarters of an hour) reach an amount sufficient to cause a distinct and marked acidity

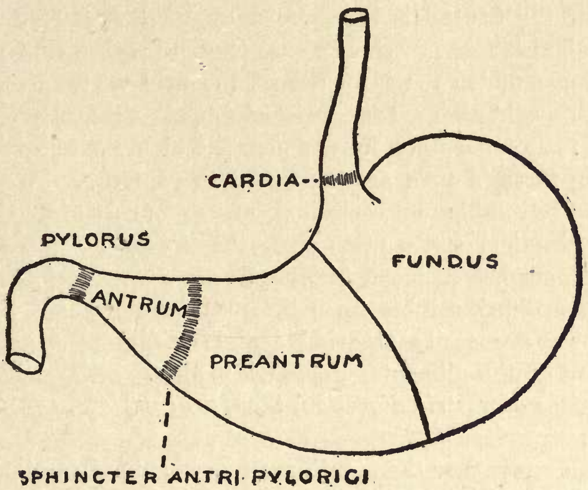

Fig. 4.—Diagram of the Stomach. The antrum and preantrum together make the so-called "pyloric end" of the stomach. The pyloric end is the active motor portion of the stomach; while the fundus serves as the food reservoir.

of stomach contents, thus superseding salivary digestion and actively beginning the gastric digestion called peptic proteolysis. If the conditions are all favorable—if the foods have been well chosen, properly cooked and masticated—gastric digestion should be completed within two or three hours after a meal. If any one of these preliminaries above named has not been properly accomplished, then the digestion may be prolonged for one or two hours longer.

As in the case of the saliva, so also in the case of the gastric juice, its flow is governed by the nervous system. The sight, taste,

and flavor of a much-relished dish eaten with keen appetite greatly influences the flow of the gastric juice, not only starting it more promptly but producing it in greater quantities. A Russian investigator, Pavlow, has called this flow in response to appetite, "appetite juice." The flow of gastric juice is also modified by the character of the food. As stated before, the gastric juice digests proteins only. So we find that, all other things being equal, the richer a meal is in proteins, the more abundant the flow of gastric juice. This flow of gastric juice induced by the chemical quality of the foods has been called by Pavlow, "food juice."

The digestion of proteins in the stomach begins, as a rule, with their change under the influence of the acid of the gastric juice into soluble acid albumates. This soluble albumin, also called syntonin, is next acted upon by the pepsin which changes it first into proteoses; these in turn are changed into peptones. Proteoses and peptones are soluble and diffusible forms of protein, much simpler in their chemical composition than the "native" proteins, such as egg albumen, lean meat, and casein that are taken in as foods. In this simplified, soluble form the proteins now in the condition of peptones are easily absorbable and readily pass through the epithelium of the alimentary canal into the blood and lymph.

The steps of gastric digestion, then, are: protein, syntonin, proteoses, PEPTONE.

The movements of the mouth are movements of mastication and swallowing. These movements are under the control of the will directly. The movements of the stomach are peristaltic and are not under the influence of the will directly. After food has accumulated in the stomach to a considerable extent in the progress of the meal, that organ begins a series of peristaltic waves that pass down from the cardiac end of the stomach, which serves as a sort of reservoir for the accumulation of food, along the antrum to the pylorus. These contractions get progressively stronger as they pass to the pylorus and take the form of a traveling, contracting ring that moves from the fundus down to the pylorus. In the earlier stages of gastric digestion the pylorus sphincter remains tightly closed. This necessitates a pouring back of the stomach contents, which have been forced toward the pylorus through the contracted peristaltic ring, thus causing a very com-

plete mixture of the food with the gastric juice. After a short time the pylorus begins to relax slightly, permitting a small portion of the liquid which is forced against it to pass through. This acid chyme passing down into the duodenum stimulates there the flow of those digestive juices which cause the intestinal digestion. If the food has been thoroughly masticated, its passage from the stomach will proceed rapidly. If it has not been thus thoroughly divided and triturated, the solid pieces of food touching the mucous membrane and sphincter pylorus will cause that sphincter to contract tightly, thus retaining the solid substance within the stomach cavity. The presence of uncooked and unchewed solid masses of food may thus result in the retention of a considerable portion of the stomach contents for hours. It is unnecessary to state that this imposes a very much greater labor on the part of the stomach, which long-suffering organ may eventually and will probably sooner or later rebel at the imposition and subject the careless individual, whose patient servant it has been, to a case of indigestion. In this way the stomach will get a much-needed vacation. Cases of indigestion are nothing more nor less than a demand of Nature for rest for the digestive system.

C. INTESTINAL DIGESTION

The food which enters the duodenum from the stomach through the pylorus is changed from acid to alkaline reaction through the agency of sodium carbonate, which is abundantly secreted in all of the intestinal digestive juices. These intestinal digestive juices, as indicated above, are *the pancreatic juice, the bile, and the succus enterieus.*

The pancreatic juice is about 98.5 per cent water and the rest solid, the solids consisting of enzymes, mucus, and salts, the enzymes being amylase or amylopsin, trypsin, and lipase or steapsin. Principal among the salts is sodium carbonate.

The bile from the liver is a greenish-brown secretion and consists of mucus, bile acids, bile salts, and bile pigment. While there are no enzymes in the bile, and while that secretion apparently exerts no chemical change other than that produced by

the sodium carbonate, still, the total influence of the bile in the alimentary canal upon the processes of digestion and absorption seems to be a very important one, from the fact that the disturbance of the flow of bile is followed very early by the disturbance of digestion and absorption.

The following functions have been enumerated as among the more important ones performed by the bile: First, emulsion of fats; second, saponification of fats; third, absorption of fats; fourth, facilitation of the passage of food along the alimentary canal perhaps through lubrication by the mucus, perhaps through chemical stimulation of peristaltic movements, and perhaps through both of these influences. Because of this more ready passage of foods and materials along the alimentary canal, the bile seems to regulate to a considerable degree the regularity of bowel movements, interference with the bile secretions being followed very soon by constipation.

The succus entericus consists of about the same proportion of water as existed in the saliva and gastric juices. The solids comprise four more important enzymes and chemical agents, secretin and sodium carbonate. The enzymes are, invertin, maltase, lactase, and enterokinase. The three digestive juices just described—pancreatic juice, bile, and *succus entericus*—are all mixed with food which passes into the duodenum from the stomach and produces chemical changes as the food passes through the duodenum and jejunum. To enumerate these changes we may begin with the action of the amylase. This starch-splitting ferment acts upon any starch and dextrin that may have passed into the intestines. As a rule, the digestion of starches has not been completed in the salivary digestion and there still remain portions of starch and dextrin. Any such remaining portions are acted upon by the amylase and changed to maltose, the steps of the change being identical with those of salivary digestion.

The trypsin acts upon any undigested proteins that have passed into the intestines from the stomach. As a rule, there still remain portions of undigested proteins, together with syntonin and proteoses. All these proteins and partly digested mid-products are attacked by the trypsin and changed into peptone. In this connection it is necessary to explain that trypsin, as it comes from the

pancreas, is inactive and requires to be activated by some other agent before it can begin its work. This activating agent is the enterokinase of the *succus entericus.*

Why this particular enzyme, the trypsin, should need to be activated while the other enzymes do not need any such activating agent is not readily seen. It has been suggested that if the trypsin were active when secreted, and if it had at first the power of digesting proteins and alkaline mediums, then the pancreatic gland itself would be digested by its own secretion. As a matter of fact, pathological cases are known where digestive changes have been made by the pent-up trypsin of a pancreatic cyst. But this is a pathological condition that is comparatively rare. Except in these rare cases, the inactive trypsin passes out of the pancreatic gland, to be first activated by the enterokinase. At the time of this activation the trypsin is mixed with partly digested food materials in the alimentary canal, whose living walls are protected by a coating of mucus. It may readily be understood that the active trypsin will exert its influence upon the food materials with which it is intimately mixed, and not upon the intestinal wall from which it is separated by a film of mucus.

If the peptones produced in the gastric and intestinal digestion are not rapidly absorbed, they are likely to be changed in part by further breaking-down processes into various simpler end products which are collectively known as the amino acids. There are two theories regarding the occurrence of these substances in the alimentary canal. One is that they are split off from the complex protein molecules in the regular course of peptone formation. The other is, as stated above, that they represent a continuation of the splitting beyond the normal point of digestion as represented in the peptones. While the former of these two theories is more reasonable, neither theory has been conclusively demonstrated. The fact remains that these amino products are always present in smaller or greater quantities.

Lipase is the enzyme through whose activity the fats are digested. It will be remembered that the fats are not chemically acted upon in the mouth. Mechanically, they are subdivided into minute particles and thoroughly mixed with other foods. While the fats themselves are not acted upon in the stomach, fatty tissue

is disintegrating through a digestion of the connective-tissue meshwork which holds the fat globules together in a tissue formation. This digestion of the connective-tissue meshwork releases the fat globules and they float in the food mass, becoming partially emulsified. The chemical action on the fat itself first takes place in the duodenum and begins with a change of reaction of the acid chyme from the stomach through the agency of the sodium carbonate.

The next step in the process is the breaking up of fat molecules into glycerin and the fatty acids. Free fatty acids are very easily saponified. Sodium carbonate, mild alkali though it is, can saponify fatty acids. The sodium soap thus formed is an active emulsifying agent, and acting in conjunction with the other emulsifying agents present in the small intestines, rapidly changes the whole of the fat to a fine emulsion which gives the intestinal contents a white, milky appearance.

Nature's plan in thus providing for the emulsification of fats is analogous to her plan in the digestion of proteins and starches; that is, the first essential step in digestion is division. Olive oil or other fats that are liquefied at body temperature—and they are practically all so liquefied—can only be brought to a fine state of division through an emulsifying agent. In the emulsion, the fat having been brought to the finest possible state of division into minute particles, the enzyme action can go forward very rapidly. As a result of this combined action of the enzyme and the free sodium carbonate the fats are rapidly saponified. These sodium soaps, being soluble in water, are readily absorbed. As they pass through the epithelium of the alimentary canal they change back again to neutral fats in minute divisions and they circulate in the body as such.

Reference has been made above to a reduction of all starches to maltose by the ptyalin and the amylase. The disaccharids, while evidently absorbable, do not circulate as such in the blood. Only monosaccharids are found in the blood. The disaccharids that are eaten as such—for example, saccharose and lactose, and the disaccharids formed as such by starch digestion (maltose)—all require to be split up into their monosaccharid constituents before they are absorbed. Three enzymes of the *succus entericus*

are devoted to this last chemical act of digestion: *Invertase* whose action breaks up saccharose into dextrose and levulose; *maltase,* whose action breaks up maltose into two dextrose molecules; *lactase,* whose action breaks up lactose into dextrose and galactose.

The final products of carbohydrate digestion are, therefore, monosaccharids consisting very largely of dextrose, either ingested as such, or resulting from the splitting up of starches, or of cane sugar, or of milk sugar, a small amount of levulose either ingested as such from certain fruits, or resulting from the breaking up of saccharose and a minute quantity of galactose from split-up milk sugar. Summing up, then, the final results of the chemical changes of digestion upon the organic foodstuffs, starch, sugar, fat, and protein, we find that the end products are three in number, namely: Monosaccharids, soaps, and peptones. All of these end products are soluble in water, readily diffusible through animal membranes, and simple in chemical structure as compared with the ingested foods.

D. INTERRELATIONS OF THE DIGESTIVE ORGANS

It will be remembered that the flow of saliva is modified by the appetite as well as by the length of time through which mastication is continued. The flow of gastric juice is modified by the appetite and by the character of the food. The work of the stomach is very greatly facilitated and, therefore, its work more perfect and more readily and quickly accomplished if the food has been not only well chosen and well prepared, but also properly masticated. The presence of the alkaline saliva also stimulates the flow of gastric juice, so in a measure, all other things being equal, the greater the amount of saliva brought in with the food, the more rapid and easy is the work of the gastric glands.

Finally, the flow of the intestinal secretions is greatly modified, if not actually governed, by the action of the segments of the alimentary canal, through which the food has already passed. While appetite exerts an influence upon the action of the pancreas, it is especially influenced by the introduction into the duodenum

of acid from the stomach. The greater the activity of the gastric gland, the greater the activity of the pancreas and the intestinal glands.

Recent researches show that this is accomplished through the agency of the *secretin* as follows: The greater the amount of acid entering the duodenum the greater the amount of secretin produced by the wall of the intestine. The secretin is absorbed and carried by the blood to the pancreas. The more secretin brought to the pancreas, the more pancreatic juice secreted. Thus, ultimately, the more acid in the stomach, the more alkali in the intestine.

From this it must be evident that if a wrong start is made in the process of digestion, the whole process will be hampered and delayed. Fortunately for all of us, the beginning of this process is wholly under the control of the will. Every person has the power of making the right start and of controlling the beginning. If one knows these principles here laid down and utilizes them continually, he may confidently expect that his digestive processes will be normal.

The influence of the appetite is so profound and far reaching that one may say, no appetite no eating. If one has no appetite, his digestive processes will be greatly retarded, if not actually associated with pain and discomfort, and the amount of actual nourishment gained from a meal thus eaten is not great enough to justify the danger of the undertaking. I would, therefore, emphasize again by repetition the paramount importance of observing this general rule: *If one has no appetite he should abstain from food.* Sometimes through exhaustion one feels faint and feels that he needs nourishment, but he has no appetite. Instead of forcing food under such conditions, it would be incomparably more wise to drink one or two glasses of cold water, repair to one's room to lie down and absolutely relax for twenty or thirty minutes. After this period of relaxation the probabilities are strong that the person will experience a good appetite for his meal.

Two great laws of hygiene which may be formulated in summing up the subject of digestion are: First, eat only when prompted by appetite. Second, chew the food and mix it with saliva until

it has been reduced to an impalpably fine state of division and is of a thin, creamy consistency. When food is thus chewed one is hardly conscious of the swallowing process, and still less conscious of the subsequent digestive processes which all follow in rapid, easy succession.

CHAPTER VI

THE ABSORPTION OF FOOD

As indicated in a preceding chapter, the digestive process seems to have for its end the preparation of food for absorption. The insoluble and indiffusible solids of the food must be made both soluble and diffusible and must be dissolved and diluted to thin limpid liquid consistency. In this condition they enter the jejunum and ileum of the small intestine. In these segments of the small intestine the wall of the intestine is so modified as especially to adapt it for the process of absorption. At short intervals along the course of the intestine—that is, every inch or so—the mucous coat of the intestine is thrown up into a transverse fold that extends nearly around the whole circumference of the intestine, closing off a considerable portion of the lumen. These transverse folds of the intestinal mucous membrane are called *valvulæ conniventes.* Their evident purpose is to retard the flow of the intestinal contents along the intestinal tract, holding it back for a time to give opportunity for absorption. Incidentally, these folds greatly increase the absorbing surface of the intestinal wall.

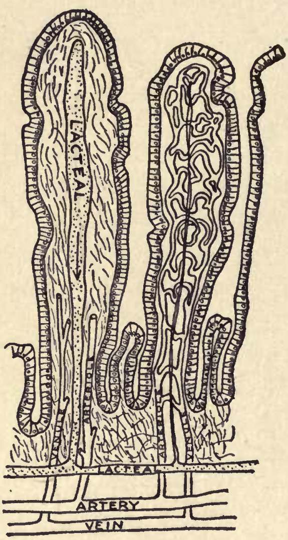

FIG. 5.—VILLI, showing lacteals and blood supply.

The organ of absorption is the villus. Villi are minute fingerlike projections that stand out upon the surface of the mucous

membrane somewhat like the nap on plush. They are composed, like the general mucous membrane of the intestines, of a layer of columnar epithelial cells, resting upon a basement membrane, and this upon a delicately meshed submucosa, within whose meshes there is a rich blood supply within capillary loops. In the midst of the villus is a sac-like lymph radical, a branch from the intestinal lymphatic system.

We thus find in the villus representatives of the two branches of the circulatory system, the blood-vessels and the lymphatics. All absorbed foods pass into one or the other of these two parts of the circulatory system. The villus is called the organ of absorption because its sole work is absorption. However, not all of the absorption is accomplished by the villi. A small amount of food material is absorbed from the walls of the stomach, and a considerable amount, particularly of the watery element, absorbed from the large intestine. Upon neither of these surfaces are villi found.

A. PART PERFORMED BY DIFFERENT SEGMENTS OF THE CANAL

Stomach.—The stomach is not an important absorptive organ. A certain amount of absorption, however, takes place through its walls into the capillary loops tributary to the gastric veins. As already indicated above, the foods ready for absorption in the stomach are dissolved monosaccharids and the peptones resulting from the gastric digestion of proteins. Recent researches have also shown that certain fats, particularly milk fats, taken in the natural emulsion represented by milk, may undergo such a change in the stomach as to fit them for partial absorption. However, the total bulk of absorption from the stomach is very small as compared with that which takes place in the small intestine.

Small Intestine.—The small intestine, fitted, as above described, with a special absorptive organ, the VILLUS, is the seat of the most active absorption. By the time the food has reached the jejunum the digestion of carbohydrates, proteins, and fats has reached a point where practically all of these foodstuffs are ready

for absorption. Furthermore, the earlier they are absorbed after they are ready for absorption, the better it is for the system, because a retention in the intestinal canal after they have reached the position ready for absorption is likely to result in further fermentative changes, due in part to the action of the trypsin, on proteins particularly, and in part to the action of bacteria, always present in the intestinal tract.

Through the walls of the jejunum and ileum the monosaccharids, the peptones, and the saponified fats are rapidly absorbed, leaving the undigested portions and indigestible portions, together with a large part of the still unabsorbed water, a large part of the bile and mucus, and most of the products of bacterial action.

Large Intestine.—The large intestine receives this soupy mass of substance just described through the ileocecal valve. Received into the cecum, the mass passes slowly up the ascending colon across the transverse colon, down to the descending colon. As it makes its way slowly through this segment of the intestinal tract, it loses a large part of the water, which is absorbed by the bloodvessels of the colon. The purpose of this late absorption of water is easy to understand. If the water were absorbed early in the process the contents of the intestinal tract would be reduced to a pasty consistency, which would make their passage along the lumen of the canal difficult and slow. The late absorption of water is evidently a special adaptation to insure the fluidity of intestinal contents up to as late a period in the process as possible.

B. ABSORPTION OF DIFFERENT FOODSTUFFS

While this subject has been in a way covered in the preceding paragraphs, there will be some value in a regrouping of the facts.

Water.—Water is absorbed to a certain small extent from each segment of the alimentary canal; especially is this necessary in the absorption of solutions, as sugar solutions, where the water serves in a measure as a sort of vehicle. However, the vast preponderance of free water is absorbed from the large intestine. The object of this is sufficiently discussed above.

Salts.—Salts are likewise absorbed in small quantities throughout their passage through the alimentary canal; these also in large degree from the large intestine.

Sugars.—While sugars are absorbed in very small amounts from the stomach, and perhaps even in slight amounts from the large intestine, the small intestine is the place where most of this process goes on.

Proteins, like the sugars, are absorbed in a small quantity in the stomach, but most of the protein absorption takes place in the jejunum and ileum. It is possible for proteins also to be absorbed from the lower portion of the large intestine and even from the rectum. This last fact is sufficiently demonstrated in clinical experience with enemata or rectal feedings. However, under ordinary conditions, the proteins that have escaped absorption in the small intestine are likely to be so modified by bacterial action as to be unfit for subsequent absorption.

Fats.—Fats, perhaps more than any other foodstuff, are absorbed in vastly greater proportion from the small intestine than from any other portion of the canal. There has been much experiment and no small amount of controversy as to the exact method of absorption of fats. An early theory of the absorption of fats was that these were reduced to an emulsion in the digestive process, and in this form were taken into the epithelial cells by a sort of ameboid activity, passed from these cells into the lymph radical of the villus, from which they made their way naturally and readily into the lymphatics of the mesentery, converging toward the receptaculum chyli, thence, by way of a thoracic duct, poured into the venous system, at the point where the left external jugular vein enters the subclavian vein. A later theory was based on the observation that a large part of the fats are saponified by the sodium carbonate abundantly present in the intestinal digestive juices. If a large part is thus saponified, why not all? So it was taught that the sodium of the sodium carbonate acted as a carrier for the fats, passing into the alimentary canal as sodium carbonate, the sodium joined with fatty acid making a soluble sodium soap, readily absorbable; after absorption, and while still within the epithelium of the villus, the sodium gives up the fatty acid, which combines with glycerin, also absorbed and within the

epithelial cells, forming new molecules of fat. These fat molecules collected into minutes globules are passed along by the cells and pushed out toward the lymphatic radical into which they make their way.

While this theory accounts for the appearance of the soap, it does not eliminate the ameboid action required in passing particles of matter as fat globules through the substance of the cells and the meshes of the tissue into the lymph radical.

The latest theory, while accepting the second so far as concerns the actual absorption of soaps, revives also the earlier theory in so far as that depends upon the passage of fat globules directly through tissues. However, this passage of the fat globules from the lumen of the intestines into the tissues is described as following intercellular spaces, the globules making their way through the cement substance that lies between the cells. Any globules actually seen in cell substance, then, are looked upon as being the result of the changing of soap molecules to fat molecules, as described above.

C. THE COURSE TAKEN BY THE ABSORBED FOODS

In our description of the villus we mention the two kinds of vessels, blood capillaries and lymph radical, representing the two portions of the circulatory system. All absorbed food is taken into one or the other of these systems of tubes. Practically all of the fat passes into the lymphatic system. Its presence in the smaller lymphatics of the mesentery in the condition of fine globules gives to these lymphatics a white milky appearance. For that reason they have from the earliest time been called *lacteals.* Nearly all of the proteins and the sugars are absorbed into the capillaries of the villus, whence they pass into the mesenteric veins, which empty into the portal vein. This vein, as you know, passes into the liver, where the sugars, at least, are immediately subjected to the action of the liver cells and are chemically changed, as will be described in the next chapter. While a vastly greater portion of the proteins pass into the venous system, a small portion at least passes into the lymphatics. This

conclusion is based upon a series of observations made by the author on chyle collected in the peritoneal cavity from a ruptured receptaculum chyli. These observations extended over a period of about four weeks, during which period radical changes were made in the diet every four days, the diet of one period being meager in fats and average in proteins and carbohydrates; of the next period, rich in fats, average in proteins and carbohydrates; of the next period, meager in fats and proteins and rich in carbohydrates; and the next, rich in fats and proteins, average in carbohydrates; and thus throughout the four weeks' period. During this time there were two periods rich in proteins and two periods meager in proteins, the others being average. The two periods rich in proteins showed a noticeably large percentage of proteins in the chyle, while the periods poor in proteins showed a smaller percentage. From this series of observations the author feels justified in concluding that at least a small proportion of proteins is absorbed by way of the lacteals.

CHAPTER VII

THE ASSIMILATION AND USE OF FOOD

Having now followed the foods in all their physical and chemical changes, until we find them in circulation in the blood, we come to a consideration of those processes which are really the fundamentally important ones. They are the end. All these other processes are only means leading toward the end. Foods are taken into the body for the energy which they contain. The essential and most important food change is the one in which energy is set free, and we are now ready to consider this change.

The chemical changes within the body are collectively called METABOLISM. These chemical changes are subject to classification in two general groups:

First, those changes in which the complex food materials or tissue constituents are oxidized and broken down into simpler materials, which are finally excreted. Incident to this oxidation, the energy of the complex material is given up in the form of heat, motion, etc. This general process is called *catabolism.* In the animal body most of the chemical changes belong to this group—that is, for the most part the chemical changes in the animal body are catabolic in character.

Second, there are certain chemical processes in the animal body in which simpler substances are built up into more complex ones. This process of building up complex substances out of simpler ones is called *anabolism.* An example of anabolism is found in the first change which the fats undergo after absorption, when they are absorbed as soaps. This change, as described above, consists in the combination of fatty acids with glycerin to form molecules of neutral fat. The neutral fat molecule contains three molecules of fatty acid with one of glycerin, and is therefore much

more complex than the molecules of which it is built up. This is a typical anabolic process. Another example is the formation within the epithelium of the intestine of serum albumin and serum globulin out of the peptone absorbed from the intestine. The steps of this process are without doubt a reversing of the steps of digestion. Digestive steps in proteolysis are hydrolytic cleavages. A hydrolytic cleavage is a splitting accompanied by the addition of water. A reversing of such a process would naturally be a combination with the release of water, and this it is which takes place in the epithelium of the small intestine, and results in the formation there of proteins out of peptones. These proteins are serum albumin and serum globulin.

A. THE WORK DONE IN THE LIVER

The liver is the great chemical laboratory of the body. A very large part of the chemical work done in the body is accomplished in the liver. As mentioned above, the liver receives from the portal vein blood containing the just-absorbed proteins and sugars from the alimentary canal. These food materials are distributed to the liver cells, and as they slowly filter through the blood capillaries between the cells within the lobules of the liver, the liver cells, which lie along the capillaries, absorb several substances, among them sugar. An important part of the work of the liver is to absorb sugar from the blood and change it into animal starch or *glycogen*. This process is called glycogenesis. While glycogen possesses the same chemical formula as starch [$(C_6H_{10}O_5)_n$], it is evidently not absolutely identical with starch in its molecular structure. However, it is insoluble in water, and the evident purpose of the formation is to take sugar out of circulation and store it in the condition of starch. After glycogen has been held in the liver cells for a few hours it is gradually given out again in the form of sugar. In order to change the glycogen to sugar, it must be redigested, and the steps of this redigestion is called glycolysis. To produce this change the liver possesses an amylolytic ferment. The process of glycogenesis is an anabolic one, while glycolysis is a catabolic process.

Another important function of the liver has to do with the proteins. While these are probably unchanged in their first passage through the liver, when they come back from active tissues, particularly from the muscle tissues, partly oxidized and broken up into simpler mid-products, the liver cells absorb these mid-products of protein catabolism, and further oxidize and combine them into the nitrogenous excreta, which will be later thrown out of the body by way of the kidneys.

Mention was made above, when we were describing the bile, of the bile pigments. These bile pigments arise from the decomposition of hemoglobin in the liver. Hemoglobin is red pigment of the red blood corpuscles. As these corpuscles become decrepit and useless they are retired from the circulation, and are caught either by the spleen or by the liver, and broken up into simpler elements. Incident to this breaking up of the hemoglobin, the iron is retained by the liver cells, while the remaining portion oxidized to the condition bilirubin and biliverdin is thrown out of the system as a constituent of the bile. This particular constituent of the bile is purely excretory, as no one has found that it serves any purpose in the digestion or absorption of food.

Another important service performed by the liver is the oxidation of toxic substances which come to it in the blood. No small part of these toxic substances comes in the portal blood, having been absorbed from the alimentary canal along with the food. Many of these toxic substances have resulted from bacterial fermentation of foods, some from the excessive proteolysis produced by trypsin when the peptone is not at once absorbed. Toxic substances finding their way accidentally into the alimentary canal along with the foods may be thus oxidized in the liver. This oxidation of toxic substances in the liver is one of the most important protective measures devised for the animal body. Among the numerous ferments in the liver are the oxidases. It is these oxidases that bring about the oxidation of the toxic substances, which oxidation, changing the substances to simpler forms, makes them harmless. A notable example of this wonderful action only recently discovered through laboratory researches is the protective oxidation of alcohol in the liver. Up to the limit of one to three ounces of alcohol in twenty-four hours, the limit varying with different

individuals under different conditions, the liver is able to oxidize and does oxidize the alcohol, thus reducing it to a harmless condition. Of all the toxic substances thus oxidized in the liver, it is probable that alcohol can be oxidized in the largest quantities. When alcohol is ingested in quantities not exceeding the physiological limit above mentioned, it is all quickly oxidized as above described. Being thus early caught in the liver, it does not exert its toxic effect upon the system. If a larger amount than above mentioned, that is, if the physiological limit is exceeded, then evidences of intoxication make themselves manifest in degree proportional to the amount taken over and above the physiological limit. These evidences of intoxication, when critically studied, are all found to be in the line of a narcosis. So alcohol has come to be looked upon as a narcotic along with ether and chloroform.

Incident to the oxidation of alcohol in the liver, two things happen that have been widely misunderstood and misinterpreted by physiologists and clinicians. In the first place, this oxidation naturally and necessarily liberates heat energy, thus increasing the sum total of body heat. Second, the oxidation of this carbonaceous substance increases the output of carbon-dioxid gas. Metabolism experiments naturally show that where alcohol has been incorporated with the foods, especially when the physiological limit is not exceeded, body heat has been increased and the carbonaceous output as represented by the CO_2 collected is greater in proportion to the consumption of fatty reserves of the body and fats of the food, than is the case when no alcohol is given. So this oxidation was easily and naturally assumed to be analogous, if not actually equivalent, to the oxidation of fats, or sugars, or starches. That being admitted, alcohol was naturally looked upon as a food. In the light of recent researches on the action of alcohol in the liver, these results, which looked so plausible a decade ago, are subject to a very different interpretation: that heat resulting from this protective oxidation is not available for maintenance of body temperature. This is evident from the fact, very generally admitted and universally known, that alcohol, in any quantity small or great, not only fails to protect the system from extreme temperatures, but actually makes the system less resistant to low temperature. Larger doses will cause an actual fall

of temperature when the individual is subjected to low temperature soon after taking the larger quantity.

When we find that no function of the body is made more efficient or in any way improved by alcohol, but that all functions which are modified at all are distinctively decreased in efficiency by the ingestion of appreciable doses of alcohol, it must be evident that the old theory that this substance possesses a food value will have to give way to the more rational theory based upon recent researches that *this substance is a pseudo-food* as it has proven to be a pseudo-stimulant.

B. THE WORK DONE IN THE MUSCLES

The muscles, representing the contractile tissue of the body, are the scene of a most extensive oxidative process during the time of their contractile activity. Furthermore, inasmuch as the body heat is for the most part liberated by oxidation of sugars and fats in the muscles, and inasmuch as body heat is continuously liberated throughout the whole twenty-four hours, it becomes evident that the muscles are the scene of a continuous oxidation, which never ceases from the beginning of life until these tissues enter a condition of rigor mortis after death. The rate of oxidation is, however, far more active during muscular work than during rest.

The oxidative changes in the muscles consist in a simple oxidation of sugars and fats into carbon dioxid and water, with a liberation of the latent heat. The oxidation of proteins in the muscles results in the formation not only of carbon-dioxid gas and water, but also of a long list of nitrogenous mid-products. These mid-products pass in the blood to the liver, where they are further oxidized and prepared for excretion as described above. As glycogen has been found in muscle tissue, it is supposed that when sugar comes to the muscles in larger quantities than can be utilized, a portion is changed to glycogen and deposited for later use. The chemical change in this process of glycogenesis and glycolysis is parallel to similar changes which take place in the liver.

C. THE WORK DONE IN THE NERVOUS SYSTEM

While the work done in the nervous system is no less important than that done in the muscular system, it seems to require a very much smaller oxidation of food materials. However, a certain amount of this oxidation always accompanies nervous activity. The food materials are conducted to the nervous system by way of the blood-vessels, and during periods of rest they are stored up in the nerve cells in granular form. These granules stored up during periods of rest represent concentrated nerve foods and are without doubt the result of anabolic processes. During periods of activity these condensed foods are oxidized, the products of oxidation being carried away into the blood and lymph. Incident to this oxidation, there is liberated as a primary and essential result the nervous energy so closely analogous to electrical energy, together with a certain amount of heat. The products of combustion are, so far as known, similar to those for the muscle tissue, and they follow a similar course in their preparation for excretion.

D. SUMMARY: TRACING THE FOODSTUFFS THROUGH THE SYSTEM

1. **Carbohydrates.**—These are absorbed as monosaccharids transported to the liver, built up into glycogen, stored there for a time,

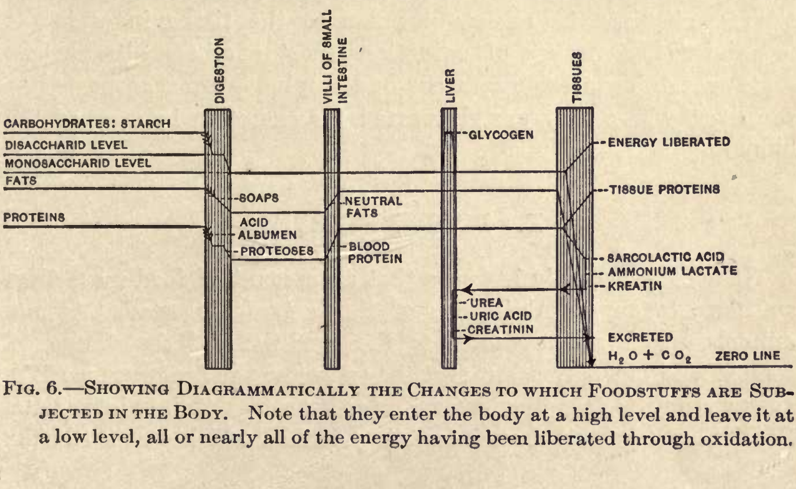

FIG. 6.—SHOWING DIAGRAMMATICALLY THE CHANGES TO WHICH FOODSTUFFS ARE SUBJECTED IN THE BODY. Note that they enter the body at a high level and leave it at a low level, all or nearly all of the energy having been liberated through oxidation.

then when they are needed, broken up into monosaccharids again, carried in the circulation to any tissues where active work is going on, especially to the muscle tissue, which is a part of the body that is always active. In the active tissue the sugar is oxidized to CO_2, and H_2O, the former carried into the lungs and thrown out in exhalations.

2. **Fats.**—Fats are absorbed either in emulsion or as fatty acids in glycerin. The latter are reconstructed into fats and passed on along with the absorbed emulsion into the lacteals, where they exist in an exceedingly fine state of division, passed through the thoracic duct into the venous system, thence, by way of the circulation, to the active tissues of the body. Here they undergo oxidative changes, which release their latent energy and result in the formation of carbon-dioxid gas and water, which is excreted in the same way as similar substances arising from the oxidation of carbohydrates.

3. **Proteins.**—These are absorbed as peptones, changed in the epithelium of the small intestine to serum albumin and serum globulin, and passed for the most part into the portal system. The proteins undergo no further anabolic change and circulate in the blood until used by the tissues. A certain amount of these proteins, as described in Part I, are used to repair or build tissues of the body. Any amount of protein over and above the amount needed for growth and repair is promptly oxidized in the active tissues, yielding the energy peculiar to the tissue in which it is oxidized. Products of oxidation—most of them nitrogenous, some containing also phosphorus and sulphur—are transported to the liver, where they are elaborated for excretion by way of the kidneys.

E. FOOD RESERVES

It not infrequently happens that an amount of food more than sufficient to supply the needs of the body is ingested. Among animals, which are subjected to the conditions of the change of season, it is very important that they store up the food excess of the summer time to tide them over the food shortage of the winter time. So Nature has devised an interesting method which consists in the

deposit of food excess in the form of fat. Experiments have shown that these food reserves, or fat reserves, may be built up from any food source—that is, fat for deposit may be built up from ingested fats, from carbohydrates, and even from proteins.

Reserve fat built up from food fats requires only to be deposited in the form peculiar to the species concerned—that is, the fat deposited in the human subject must contain the stearin, palmitin, and olein in the proportions peculiar to human fat, though these neutral fats are ingested in the proportions very different, some coming from vegetable oils and some from milk and butter, and others from animal fats.

Reserve fat built up from carbohydrates represents an anabolic process in which the comparatively simple monosaccharid molecule is step by step built up into the rather complex fatty acid molecule, and these later combine into the neutral fats by uniting with glycerin. This anabolic process of building the fats out of monosaccharids is probably done in the liver, and it results in the liberation of free oxygen. It is not unlikely that this liberation of oxygen in the liver greatly facilitates the action of the oxidases in that organ, and may account for the fact that the great activity of oxidases, as in the habitual and repeated oxidation of alcohol, is associated with the formation of fat and its tendency to deposit in that organ, the fatty liver being a clinical phenomenon very widely and not infrequently observed.

Reserve fat built from proteins is probably the result of a cleavage of the protein molecules. These cleavages are, as a rule, easier to accomplish in the general metabolism than the building up. Just how these take place, however, in the formation of fats from proteins cannot be determined until we know the molecular construction of the protein molecule.

F. BODY HEAT AND HEAT REGULATION

Reference has been made repeatedly to the heat liberated as a result of the oxidation of foods, and of tissue elements. The heat of the body arises from these sources only. As heat is continually leaving the body, it is evident that it must be continually liber-

ated in the body in order to maintain an equable body temperature. It has been estimated that during a twenty-four-hour period the average individual loses not less than 1,800 calories of heat from the surface of the body. Nearly 400 calories are estimated to be carried away from the body through the evaporation of moisture from the surface of the skin, and nearly 200 through the evaporation of moisture from the lungs, while over 50 are lost in the excreta. In round numbers, approximately 2,500 calories of heat leave the body in twenty-four hours. When we consider that the average individual takes in with his food about 3,000 calories per day, it must be evident that about five sixths of all the energy received latent in the foods is consumed in simply maintaining body temperature.

Before proceeding further it may be wise to define the calory. A calory is that amount of heat required to raise 1 kilogram of water 1° centigrade. The same amount of heat would, of course, raise 500 grams of water 2° centigrade, or 100 grams of water 10° centigrade.

There are certain general principles of great importance which must be remembered in all discussions of body temperature. *First: Anything which causes an increase of tissue activity causes an increase of liberation of heat in the body, and conversely, anything which causes a decrease of tissue activity causes a decrease of heat liberated in the body.* Most important of the things causing increased body heat is muscular work. The reason why muscular work increases body heat is very evident. A large amount of fat, dextrose and proteins are oxidized within the muscles during their activity. Incident to this oxidation, the heat, being liberated from these substances and distributed through the body, tends to raise its temperature. Mental work for similar reasons tends to raise body temperature, though to a very much smaller degree than muscular work. The ingestion of food into the alimentary canal, resulting as it does in the activity of a large number of glandular structures, also increases temperature.

These three causes of increase already mentioned—viz., muscular work, mental work, and the ingestion of food—are all activities of the waking hours. These activities reach a maximum usually in the afternoon, and, as a result, observations on the body tem-

perature show that it gradually rises from five in the morning to six in the afternoon, covering a total of about 1° C. or 1.8° F. As a rule, body activity decreases from this time on. The partial rest of the evening is followed by complete rest during the hours of sleep. As a result, the temperature gradually falls from six in the evening until five the following morning, when it reaches a minimum.

This fact of the daily wave of temperature must always be remembered by the nurse and physician, as an observation in the early morning hours is certain to be below the average; but though it is below the average, it is not subnormal. If the same temperature, however, were observed at six in the afternoon it might be looked upon as subnormal. In a similar way 0.5° above the recognized average human temperature, when recorded late in the afternoon, must not be looked upon as representing any degree of fever. However, if the same temperature were found at five or six in the morning, it might be looked upon as representing a slight febrile condition.

A *second* principle always to be remembered is that: *Anything which causes an increase of heat radiation or heat conduction from the surface of the body tends to lower the temperature of the body.*

Low temperature of the air which comes into contact with the body will carry away heat from the surface of the body, therefore tend to lower its temperature. In order to avoid an actual lowering of temperature through the action of cold air, the body possesses a natural defense in the form of a neuromuscular adaptation, which results in a rapid evolution of heat in the muscles to offset and equalize the heat lost from the surface of the body. If, for any reason, the neuromuscular system is unable to make this response, then subjection to lower external temperatures may be fraught with danger. Perspiration is the most effective means for lowering body temperature. For every gram of water that evaporates from the surface of the body nearly three fifths of a calory of heat is carried away. In this way alone the average individual under average conditions loses, as stated above, nearly 400 calories of heat during twenty-four hours. If a person perspires very freely, as he would do if he were exercising actively in warm weather, this amount would be very greatly increased. Both the

methods of decrease mentioned above are natural ones, active almost continuously under usual conditions.

An artificial method of lowering body temperature is the bath, when this is administered in such a way as to leave the body exposed to evaporation of moisture from the wet surface. If a warm-blooded animal is immersed in a bath warmer than its blood temperature, the temperature of the animal will rise for reasons easy to understand. If the temperature of the bath in which the animal is immersed is lower than that of its blood, the temperature will tend to fall at first, but the cold water will stimulate the neuromuscular heat regulation mechanism, and thus quickly bring the temperature back to its original condition before it was subjected to the cold bath. If, now, instead of immersing the animal in the bath, it is given a tepid shower, or a tepid sponge bath, the heat-generating center will not be stimulated into activity and the evaporation of the tepid water from the surface of the bath will cause a marked decrease of body temperature.

HEAT REGULATION

For those who have the care of the sick, heat regulation is a matter of very great importance, because it has to do with the care of the fever patient. The temperature of the body can rise above the normal, either through an increased heat formation (thermogenesis) or through a decreased heat loss (thermolysis). Body temperature, then, is governed absolutely by the interaction of these two factors, thermogenesis increasing it and thermolysis decreasing it. Anything which increases thermogenesis raises the temperature until that is adjusted by a corresponding increase of thermolysis. Anything which increases thermolysis decreases the temperature until that is adjusted by an increased thermogenesis. In order to maintain an even temperature these two factors of body heat, thermogenesis and thermolysis, must increase and decrease together. A change of one must be followed by a change of the other in the same direction, or the body temperature will become subnormal or above normal as the case may be. Temperature above normal, if considerable and maintained for an appreciable length of time, is called fever.

From time immemorial, those who have had the care of the sick have recognized fever as one of the most important symptoms of sickness, and have attempted to control it by various methods.

From the standpoint of the dietitian heat generation may be increased by the ingestion of solid foods that require considerable activity on the part of the glands of the digestive system. As a rule, then, the first step in the dietetic control of fever should be to decrease foods to the minimum of the body's requirement and present these foods in the condition most easily digested and assimilated.

Further, certain foods and beverages, particularly the latter, possess a diuretic and diaphoretic action. The free ingestion of these foods, which increase skin and kidney action, tends to lower body temperature through increasing the thermolysis.

CHAPTER VIII

GETTING RID OF WASTE MATERIAL

Whenever food or fuels are burned, oxidized for the energy which they contain, products of oxidation accumulate and must be eliminated. This is as true in the animal body as in the engine. In the latter accumulating smoke gases, acids and clinkers would put out the fires if not promptly disposed of. In a similar way in the animal body accumulated carbon-dioxid gas and nitrogenous and other waste materials would soon extinguish the " spark of life." As in the engine, so in the animal body, accumulating gases are much more rapid in their action than accumulating solids. If the draft smokestack of the engine were stopped, so that the carbon dioxid could not rapidly pass away, it would require only a few minutes to put out the fire; and if the respiratory passages of the animal were closed, death would follow in a few minutes. If clinkers were permitted to accumulate on the surface of the grate the engine's fire would probably continue for a number of hours, perhaps a whole day, but not indefinitely. Similarly, if the nitrogenous and like excreta are allowed to accumulate in the blood through failure of the kidneys to expel them, an animal would die in convulsions within a day or two. This should illustrate once for all the absolute necessity for getting rid of the ever accumulating waste material. This process is called excretion and is participated in by lungs, kidneys, skin, and intestines.

A. THE WORK OF THE LUNGS

The lungs are the respiratory organs and perform a double function. First, to take up oxygen from the air, which is absorbed

through the moist thin membrane of the air sacs into the blood of the capillaries. Second, to exhale carbon dioxid into the air. This is carried from the active tissues of the body in the venous blood to the lungs, and diffuses through the capillary walls into the air contained in the air cells. Thus the air which is exhaled out of the lungs contains much less oxygen and much more carbon dioxid than the air which is inhaled.

Incidentally, the lungs give up a certain amount of water and minute quantities of organic material; both of these exhalations, however, are incidental. The excretion of importance in the lungs is the carbon-dioxid gas.

B. THE WORK OF THE KIDNEYS

The sole work of the kidneys is excretion. In this respect the kidneys differ from many organs of the body; the lungs, for example, perform the double function of absorbing oxygen and excreting carbon-dioxid gas. The liver performs several unrelated functions, as detailed above. The kidneys, however, devote their activity to excretion exclusively; they are the excretory organs par excellence. The blood passes through them from a short transverse branch on the abdominal aorta in far greater quantities than would be necessary to supply the kidneys with nourishment and oxygen. This blood is sent to the kidneys, not for the kidneys' sake, but for the blood's sake. It is sent to the kidneys to be purified. We have here, therefore, the unusual occurrence of a greater purity in the venous blood coming away from an organ than the arterial blood going through the organ. The kidney is composed of a very great number of tubes called the uriniferous tubules. Each tubule starts in a little tuft of capillaries inclosed in a sac. The tuft is called a glomerulus. The sac is called Bowman's capsule. Starting thus in a glomerulus, the tubule, lined with secreting epithelium, undergoes a great many changes in direction; in fact, it is almost as tortuous as the small intestine, and empties finally into the pelvis of the kidneys. Each tubule may be subdivided into two portions: the glomerulus and the convoluted portion. These two portions have two very distinct functions.

Glomerular Excretion.—When the blood filters through the tuft of capillaries within the glomerulus, water and salts of the blood pass out in a sort of filtrate, are caught by the Bowman's capsule and pass into the lumen of the tubule. The amount of water and salts thus filtering out of the blood will depend, of course, upon the excess of these substances in the blood. If a large amount of water has passed away from the surface of the body as perspiration, there will be less water to be excreted by way of the kidneys. On the other hand, if one has been drinking quite freely of water during a warm spell, and there comes a sudden change in the weather, accompanied by a fall of temperature and much moisture in the air, the perspiration will suddenly be much decreased in quantity. This will leave the blood with a considerable excess of water above the average or normal. Under these conditions there will be a copious filtration of water and salts through the glomeruli into the tubules. This naturally results in a large volume of light-colored, diluted urine, while the urine in dry, hot weather is likely to be dark-colored and more concentrated, due to the small amount of water.

Tubular Excretion.—Surrounding each tubule is a rich meshwork of capillary loops, through which the blood slowly oozes, after it has passed through the tuft or capillary glomerulus. The active secreting cells that make up the wall of the tubules thus have blood on one side and the open lumen of the tubule on the other side, filled with water just filtered off in the glomerulus and making its way along the tubule to the pelvis of the kidneys. The kidney cells take up nitrogenous and other waste materials from the blood of the capillaries and throw it out on the other side into the water.

Among the substances thus removed from the blood and secreted into the water are: urea, uric acid, urates, sulphuric acid, sulphates, sodium phosphate, xanthin bodies, conjugated sulphates. Note that all of these substances contain either nitrogen or sulphur or phosphates. They are substances which cannot be excreted by the lungs, nor by other excretory organs in more than slight traces. They result from the oxidation and catabolism of the protein. Some of the proteins thus catabolized have been a part of the living, active tissues, while others are catabolized di-

rect. In any case, whether tissue protein or fuel protein, its oxidation yields these substances above enumerated, and they can be excreted only through the kidneys. Interference in the action of the kidneys, then, results in the retention of these substances in the blood. Such a condition is called uremia, and rapidly produces a condition of intoxication called uremic poisoning. Such a condition acknowledges itself by profound influence on the neuromuscular system as evidenced by appearance of convulsions. If the condition is not quickly relieved the patient will die in convulsions.

Any substance which causes increased activity of the kidneys is called a diuretic. We have already, in discussing the citrous fruits, mentioned the diuretic effect of juices of these fruits, the active agent in the juice being the citrate of the alkalies.

Water, when taken copiously, also has a diuretic effect. Some diuretics exert their influence indirectly through increasing blood pressure. Digitalis exerts a diuretic effect in this way.

C. THE WORK OF THE SKIN

While the skin is usually named among the excretory organs, excretion is more or less incidental, the principal function of the skin being protection; as a part of its protective function, the skin secretes oil from its sebaceous glands. Another part of its protective function is regulating body temperature. Incident to this regulation of body temperature water may be poured out in large quantities; this water is naturally drawn off from the blood and represents an excess above the minimum water content of the blood. If this amount is exceeded one experiences thirst and takes more water to make good the shortage. Any excess above normal water content of the blood, after the skin has made the necessary drafts in its temperature regulation, will be excreted by the kidneys as described above. Thus we have a perfect reciprocal relation between skin and kidneys in excretion of excess water. Incident to the excretion of water from the sweat glands of the skin, certain salts are also excreted, and these salts are practically the same as those excreted by the kidneys, even including urates in traces.

D. THE WORK OF THE INTESTINES

A considerable bulk of waste matter passes away from the intestines daily as feces. Much the greater part of this fecal matter represents the indigestible and undigested food materials or food accompaniments that have passed throughout the whole length of the alimentary canal. The most important part of this undigested material, so far as bulk is concerned, is the cellulose of vegetable tissues, while a small part of the cellulose, particularly such tender cellulose as that in crisp celery, cabbage, and other vegetables, is digested in the human digestive canal. All the tougher cellulose structure, such as that found in cereals and legumes, and a large part of that in vegetables and fruits, passes through the human alimentary canal undigested. This is not to be looked upon as a disadvantage; on the other hand, it is considered by physiologists to be distinctly advantageous to have a certain amount of undigested material in the alimentary canal, because this bulk of undigested material serves as a carrier or vehicle for the excretory and other materials to be enumerated later. The presence of this cellulose stimulates the peristaltic action of the intestinal walls, and thus favors regularity of the bowels. Besides the cellulose, there are bile pigments, bile salts, mucus, amino acids, and other products of decomposition of proteins, together with a slight amount of unabsorbed fats, and products of bacterial fermentation and putrefaction within the intestines.

Of all this mass of material that makes up the feces only a very small amount can be classified as real excretion, because an excretion is a substance which has been within the tissues. Only those substances, then, in the feces which have been poured out with the bile, or from the walls of the intestinal cells, in order to rid the system of them, should be counted as excretion. All the other substances are simply ejecta. Even the mucus poured out by the wall of the large intestine to facilitate the movement of its contents would not be called an excretion, though it is a part of the feces. It was not poured out into the intestine in order to get rid of it, but was poured out to serve a particular purpose. The bile pigments, on the other hand, are taken out of the blood and poured into the intestine in order to get rid of

them. They serve no purpose in the intestine; they represent purely excretory material. Retention of this material, through a derangement of the liver function, makes itself manifest in the yellow, jaundiced color, due to the tingeing of the tissues by the bile pigments.

PART THREE

DIET IN HEALTH

CHAPTER IX

FUEL VALUE OF FOODS

In the preceding pages reference has been frequently made to the fuel values of food and an analogy drawn between the use of fuel foods in the animal body and the use of fuels in an engine. It is a well-known fact that the energy liberated by an engine is simply the latent energy of the fuel burned in the furnace of the engine. If all of this energy latent in the fuel of an engine could be accurately measured when it is oxidized in the furnace, the summed-up energy expenditure in heat, motion, and other forms would exactly equal the latent energy of the fuel. Such an observation would be accepted as a proof of the law of conservation of energy. It is a general law universally recognized that energy may be transformed into many forms without being actually lost. Of course, it must be recognized that in this transformation some of the energy appears in a form that cannot be utilized; hence it may be commercially lost. For example, the heat that radiates from the surface of the furnace heating the surrounding air instead of the water in the boiler, while commercially lost, is not destroyed.

The law of the conservation of energy holds good for the animal kingdom as it does for the locomotive. The total amount of energy leaving the body is, without reference to its numerous transformations, exactly equal to the amount received by the body. A very small part of the energy received from the body comes direct from the sun, or from artificial heating appliances in the form of heat, but a vast preponderance of the heat of the body comes from the food.

A. MEASUREMENT OF FUEL VALUES

The unit of measurement of fuel value is the calory, already defined above as that amount of heat required to raise the temperature of one kilogram of water to 1° centigrade.

To determine the fuel value of a food, an instrument called the calorimeter (see Fig. 7) is used. Various forms of calorimeter have been devised during the last century and a quarter. One of the

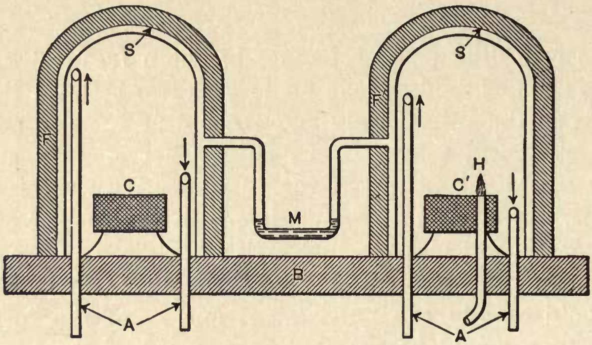

Fig. 7.—Diagram of the Air Calorimeter. B, base; F, layer of felt; C, cage; A ventilation tubes; S, air space; M, mercury manometer; H, hydrogen flame. (After Haldane, White & Washburn.)

best recent forms of calorimeter is that devised by Haldane, White & Washburn and described in the *British Medical Journal* (London, 1897, vol. ii, p. 11). It consists of an animal chamber or combustion chamber, and a control chamber (see accompanying figure). The body whose heat is to be determined is put into cage 1. In the control cage (2) hydrogen is burned in quantity sufficient to keep the mercury manometer balanced. The number of cubic centimeters of hydrogen burned in an experiment is observed. The calories produced by one cubic centimeter of hydrogen are known, thus the gram-calories given off by the body to be tested becomes known. Through the aid of the calorimeter one may determine not only the heat given off by the combustion of any oxidizable material, such as carbon, fat, starch, albumin, alcohol, sugar, etc., but also the amount radiated or conducted

away from any body—for example, a living animal. The following table gives the calories represented in different foods and other substances involved in nutrition:

SUBSTANCE. (1 Gr. Dry.)	Heat of Combustion in Calories.
Starch or glycogen	4.182 calories.
Cane sugar	4.176 "
Dextrose	3.940 "
Lactose	4.162 "
Carbohydrates, average	**4.** "
Fat (one form)	9.686 "
Fat (another form)	9.423 "
Butter	7.264 "
Fat, average	**9.4** "
Egg, white	4.896 "
Egg, yolk	6.460 "
Egg average, white and yolk	5.678 "
Lean beef	5.656 "
Casein	5.849 "
Vegetable proteins	5.500 "
Proteins, average	5.650 "
Protein, unavailable energy	1.650 "
Proteins, available energy	**4.** "
Carbon, per gram	8.080 "
Hydrogen, per gram	34.662 "

Inasmuch as the ingested starch is reduced to dextrose before absorption, and inasmuch as a considerable portion of fruit and vegetable sugar is ingested as dextrose, the average for carbohydrates in general can be taken as very close to the average between dextrose and cane sugar, but nearer to the dextrose value. This average is so close to four calories per gram that no appreciable error will be introduced by assuming for carbohydrates the value of four calories per gram.

Of all these values given in the above table, the following will be used in the subsequent computations:

Carbohydrates	4.0 calories.
Fats	9.4 "
Proteins	4.0 "

It may be noted in passing that the unavailable energy of the proteins is that represented by the urea, urates, nitrates, sulphates, and other more or less complex substances of the urine, which are subject to further combustion, so that the animal body is only able to extract from proteins about four calories, while the calorimeter in complete combustion is able to extract 5.65 calories.

In computing the energy represented by a particular menu one deals with several carbohydrates in various proportions, similarly with several fats and several proteins. Instead of computing the different carbohydrates separately, it is customary to use the average value given in the last table, and to multiply the total amount of carbohydrates in the menu by that factor; the other foodstuffs are treated similarly. To determine the energy which any food represents, it is only necessary to find, by analysis, the percentage of protein, of fat, and of carbohydrates which the food contains, and to multiply these amounts by the factors given in the above table. For example, oatmeal contains 7.6 per cent of water, 15.5 per cent protein, 7.1 per cent fat, 68.2 per cent carbohydrates and 2 per cent salts. One hundred grams of oatmeal represent energy:

From protein	$15.1 \times 4.0 = 60.40$
From fat	$7.1 \times 9.4 = 66.74$
From carbohydrates	$68.2 \times 4.0 = 272.80$
Total	399.94

The energy of one pound of dry oatmeal is obtained by multiplying this quantity by 4.5.

Thus in the measurement of fuel values of food it is necessary to have before one tables showing the chemical analysis of the food in question. Knowing the amount of these foods or foodstuffs used, and utilizing the factors given in the table above, one can quickly determine the calories per 100 grams or the calories per pound.

B. RELATION OF FUEL VALUE TO DIET

Having explained the relation of fuel value to expended energy, it must be evident that this relation is a very definite and constant one. We have not, however, made any reference to the relation of fuel value to growth and repair. Foods used for these purposes, not being oxidized at the time they are so used, do not liberate their latent energy and cannot, therefore, immediately be computed. That is, the outgo will not at once balance the income. Carbonaceous foods deposited as fat reserves must be treated in a similar way, so that an energy balance cannot be struck in an individual rapidly increasing in weight, because a part of the weight, in the case of a young individual, may represent deposited proteins in body growth, and a part deposit of fats. Eventually, however, all these deposited materials, whether proteins or fats, will be oxidized, and when oxidized they yield the energy which has been held latent throughout the period of deposit. There must, therefore, exist a very definite relation between the fuel value of the diet and the work accomplished, whether this work be active labor of some kind or the laying up of reserve tissues.

C. RATIONS FOR AN AVERAGE CASE

Let us take the case of an average-sized man engaged in light work. An average menu for one day for such a man might be as follows: Bread, one pound (453.6 grams); lean meat, half a pound (226.8 grams); oysters, half a pound (226.8 grams); cocoa, one ounce (28.3 grams); milk, four ounces (113.2 grams); sugar, one ounce (28.3 grams); butter, half an ounce (14.17 grams). If one were to tabulate these food materials under three columns, multiplying the number of grams of bread by the percentage of protein, of fat, and of carbohydrates, arranging the results in columns under protein, fat, and carbohydrates, similarly for each food, he would find a total of 106.8 grams of protein in a day's menu, 57.97 grams of fat, and 398.84 grams of carbohydrates. To find the energy value of such a day's menu one has only to mul-

tiply the protein by 4, the number of calories per gram of protein; the fat by 9.4, the number of calories per gram of fat; and the carbohydrates by 4. This sums up a total of 2,566.78 calories in the day's menu.

It must be evident that a menu containing approximately this energy total could be arranged from almost innumerable different combinations of foods. In the arrangement of a menu the total protein has usually not been allowed to fall below 100 grams per day, or a little over 3 ounces of dry proteins. The fat has usually not been allowed to fall much below 60 grams (2 ounces) per day, and the carbohydrates to approach 400 grams (13 ounces) per day. The total calories for a man at light, indoor work should not fall below 2,500 calories; it is more usual to have it approach 3,000.

However, researches made by Professor Chittenden, of the Sheffield Scientific School, Yale University, have shown that, at least so far as the protein is concerned, the fuel value can be considerably reduced. His experiments carried through on three groups of men—a squad of soldiers from the United States Army, a group of athletes from the Yale athletic team, and a group of faculty men—all showed the same thing—namely, that the amount of protein can be reduced considerably below 100 grams per day without disturbing the nitrogen equilibrium, and without causing any appreciable loss of weight, and certainly without any loss of physical or mental power or efficiency. In the light of these extensive observations of Professor Chittenden, it seems evident that we can safely reduce the protein to sixty grams or two ounces per day dry weight.

When we consider the cost of proteins in the market, and the fact that any excess of proteins over and above the minimum required for the maintenance of nitrogen equilibrium is oxidized in the muscles simply for fuel, it must be evident that beyond the minimum required it is much more economical to use carbohydrates and fats for fuels.

D. RATIONS FOR DIFFERENT CONDITIONS

Conditions.	Proteins.		Fats.	Carbohydrates.		Energy in Calories.
	Low.	High.		Low.	High.	
Man at light indoor work....	60	100	60	390	450	2764
Man at light outdoor work....	60	100	100	400	460	2940
Man at moderate outdoor work	75	125	125	450	500	3475
Man at hard outdoor work....	100	150	150	500	550	4000
Man at very hard outdoor winter work..............	125	180	200	600	650	4592
U. S. Army rations...........	64	106	280	460	540	4896–5032
U. S. Navy rations...........		143	292	557	......	5545
Football team (old régime)...	......	181	292	557	......	5697
College football team (new)...	125	125	125	500	......	3675

Rations Varied for Sex and Age.

Variations of Sex and Age.	Proteins.		Fats.	Carbohydrates.		Energy in Calories.
	Low.	High.		Low.	High.	
Children, two to six..........	36	70	40	250	325	1520–1956
Children, six to fifteen.......	50	75	45	325	350	1923–2123
Women, with light exercise...	50	80	80	300	330	2272
Women, at moderate work....	60	92	80	400	432	2720
Aged women................	50	80	50	270	300	1870
Aged men..................	50	100	400	300	350	2258

CHAPTER X

THE MENU

A. GENERAL PRINCIPLES GOVERNING THE CONSTRUCTION OF THE MENU

There are certain fundamental principles which should govern the dietitian, the physician, the nurse, and the mother, in choosing a diet for those under their care. In the first place, if one is choosing a diet for one individual, he should take into consideration, first of all, the age, next the health of the individual, and finally the conditions under which the individual is living, whether active or inactive, indoors or outdoors. Other factors that may be taken into consideration are the tastes of the individual and the cost of food materials. Considering the complexity of a combination of these factors, when the head of a household is required to arrange a dietary for a family in which there are old and young, robust and frail, and to keep this dietary within a certain stipulated sum of money, it is evident that the problem is not an easy one. The most important fundamental thing to determine is the amount of protein which is to be given. If the individuals who are to be provided are robust and active, the high protein diet may be selected with perfect confidence that it will be taken care of by the individual. Having decided on the amount of protein which the diet is to represent, one should next consider the form in which this protein is to be given. Upon this decision will depend largely the general character of the dietary, whether it is to be a mixed diet in which proteins are largely provided by lean beef, an ovo-lacto-vegetarian diet in which the protein is to be largely provided by eggs, milk, and legumes, or a vegetarian diet in which the proteins are to be found in legumes, cereals, and nuts only. The next thing to determine in regard to the diet is the amount and source

of carbonaceous foods. Inasmuch as these foods include starches, fats, and sugars, it must be decided whether the diet shall be rich in fats or poor in fats. Perhaps the individual who is to be provided does not crave fats, which is a very common thing to observe. In that case the quota of carbonaceous foods must be made up largely from the carbohydrates. It may also be found that the individual cannot take large quantities of sugar because of a tendency to fermentation in the stomach, or in the case of the choice of fats, the individual may not be able to eat fat meat at all, but may relish cream and butter. After taking all of these things into consideration, the dietitian determines first the total energy which should be represented in the ration of one day. Next, the proportion between the three groups of organic foods—namely, proteins, fats, and carbohydrates. Let us suppose that the individual is a medium-sized man at moderate work out of doors, and that the man is in robust health and craves meat. We will choose a mixed diet and assign a ration of 125 grams of protein. Having chosen the high protein diet, we will take the low carbohydrate diet. If we had chosen the low protein we would have to take the high carbohydrates, in order to introduce into the diet the same caloric value.

B. EMPIRICAL FOOD-BALANCE IN "DISHES"

In studying the dietaries of people in all times, it is very interesting to note that the use of composite foods is universal, and further, that these compounded foods are composed of the ingredients that form a dietetic balance. One of the simplest compositions that could be cited is *bread and butter*. A glance at the chemical composition of bread shows that, while it has a proportion of protein and of carbohydrate, fitting it for a complete food, it is short in fats. When one eats bread he craves fat of some kind with it, and so from time immemorial people have spread butter upon bread, or they have dipped it in beef fat, or have spread upon it rich gravies, in this way adding to bread the foodstuff that it most lacks. *Pork and beans* is another composite food in which the fat of the pork supplements the proteins and carbohydrates

of the beans, making a close approach to a perfect food-balance. *Macaroni and cheese* is easily prepared, with milk and some added fat, perhaps butter, besides the butter-fat in the cheese, and is another good example of the composite food or "dish" in which there is a fairly perfect balance of proteins, fats, and carbohydrates. On such a dish as macaroni and cheese one could make a complete meal, satisfying every requirement of the body. In a milk *custard* we have eggs, milk, and sugar, forming a combination in which the proteins, fats, and carbohydrates are so balanced as to make the dish a perfect food. A whole meal could be made on such a dish and satisfy every requirement of the system.

C. TYPICAL MENUS FOR AVERAGE CONDITIONS

1. A Student's Menu.—Let us take the case of a young man of twenty-one, who has reached his full stature of physical growth. He is in good health, but restricted in means. He must, therefore, practice economy in his food, as well as in his clothes and other expenses. Whether he boards at home, at a student's boarding club, or in a private boarding house, he ought, at a cost of three dollars per week, to provide an adequate diet. He will be wise to choose a low protein diet. Whether the protein is furnished in part through a small portion of meat once a day, or two eggs and a pint of milk, is a matter of little consequence. On the whole, it will probably be best to have meat once a day for four or five days each week, and eggs or baked beans the other days. He may have a menu constructed along the following lines:

BREAKFAST

Oatmeal, one ample portion, with sugar and cream.
Dry toast, two slices.
Cereal coffee, one cup.
Grapes, one bunch. how big

LUNCH

Creamed soup (potato, tomato, celery), with croutons,
Bread and butter.
Fruit (baked apple, stewed apple, rhubarb or prunes).
Cake, and a glass of milk.

DINNER

Roast beef with brown gravy.
Potatoes.
A vegetable (fresh peas, beans, corn, cabbage, spinach, or cauliflower, etc.).
Bread and butter.
A fruit (apple sauce, rhubarb, cranberry sauce, or canned fruit).
Rice pudding, with lemon cream sauce.

2. **A Football Player's Menu** (new régime).—It used to be customary for the football player to be stuffed like a Thanksgiving turkey. As a common result of the gross overfeeding of these football players, they were almost certain within two or three weeks after entering upon training, to train "stale." This is simply another term for expressing the fact that their system became clogged full of fatigue-products and mid-products of protein oxidation. When a man has trained "stale" he takes two or three days off from active field work and takes a course of physic, baths, massage, and sweating; the effect of this heroic treatment is to rid his system of these accumulated waste products. After two or three days of such treatment he is usually able to take his place in the line again.

The new régime is arranged with a view to avoiding the occurrence of training "stale." The first step in this is the reduction of the menu to reasonable proportions, and especially the reduction of the quantity of proteins. While meat may be taken twice a day, or even three times a day, it is taken in small portions. The carbohydrates and fats are taken abundantly but not to surfeit. The following menu would be a proper one for men in training for football:

BREAKFAST

Fruit (grapes or banana, apple or orange).
Two boiled eggs.
Cereal with cream and sugar.
Three slices buttered toast.
Cup of coffee.

LUNCH

Soup, a rich cream or purée with croutons.
Two lamb chops.
Creamed potatoes.
Bread and butter.
Fruit (stewed or canned).
Cake.
A glass of milk.
After the practice, a glass of lemonade or an egg lemonade.

DINNER

Clear soup (vegetable or meat), small portion.
Roast leg of mutton with brown gravy.
Baked potatoes.
Vegetable (beans, peas, corn, parsnips, carrots, etc.).
Fruit (apple sauce, rhubarb, cranberry, or stewed or canned fruit).
Bread and butter.
Dessert (cup custard or rice pudding or bread pudding, or tapioca and fruit). Water.

CHAPTER XI

FOOD FOR HEALTHY PEOPLE

A. FOOD FOR THE GROWING CHILD

It is proposed, under this topic, to make no reference to food for the infant, as this is to be very fully discussed in the succeeding chapter.

After the child has reached the age of one year he should begin to receive a general diet, chosen from the dietary of the family. Having been accustomed to a milk diet, almost exclusively, when it begins to have solid food the transition should not be a sudden one. Nature makes no sudden transition. All transitions are gradual. So, following the general principle of a gradual change, the parents should give the child something that will tend to develop his digestive functions. The child of one year is cutting teeth. He needs something to bite on. The child is gradually developing the power to digest starches. He needs some starch to work on. A piece of dry toast answers this double requirement probably better than anything else that could be devised. Rich whole milk may be freely given to most children during the second, third, and fourth years; in fact, one or two glasses of milk a day is altogether in place as a regular part of the dietary of any child until he enters the adolescent period. It makes, naturally, a progressively smaller and smaller part of the dietary after the first year. Cereals and fruits and eggs should make up the diet of a young growing child; while there is no objection to a small amount of meat, it should always be a small amount.

The growing child is building up tissue, muscle, brain, bone, and gland. He must, therefore, have plenty of proteins; milk, eggs, and cereals will furnish these in abundance. At this stage

in his development the child is acquiring habits, as clearly indicated in the preceding chapters; the habit of properly masticating the food is a most important one to acquire. It should be acquired during early childhood; it can only be so acquired by necessity. If the mother gives the child soft mushes and semiliquid foods, these will be swallowed without chewing, very greatly to the detriment both of the dental development and of the development of the digestive glands. Nearly all of the foods which the child uses should require chewing. He is almost certain to be hungry between meals. If he is hungry enough to gnaw at a dry crust, he will get only benefit from the "piecing" between meals. If, however, he receives two or three slices of soft bread and jam, he is almost certain, first, to swallow the food with inadequate chewing, and second, to eat more than he needs, which will overload the stomach and overtax its activities, so that at the next regular meal-time he will have no appeptite. Such a method of caring for the dietary of the child will surely result in a serious disturbance of his whole digestive function, which will handicap him throughout life. A rational day's ration for a healthy four-year-old child might be as follows:

BREAKFAST

A glass of whole milk.
Small portion of thoroughly cooked oatmeal with cream and sugar.
Baked apple.
Small piece of buttered toast.

TEN O'CLOCK LUNCH

A small portion (equal to a heaping tablespoonful) of parched sweet corn, or two graham crackers.
Glass of water.

ONE O'CLOCK LUNCH

Cup cambric tea (hot water and cream sweetened).
Bread and butter.
Creamed potatoes.
Fruit, stewed or fresh.

FOUR O'CLOCK LUNCH

A dry crust or a piece of cold, dry toast, or a pretzel, or two graham crackers.

SUPPER

Glass of milk.
Soft-boiled egg.
Shredded wheat biscuit with cream.
Fruit (apple, grapes, banana, or orange).

Innumerable variations may be made in such a dietary, but all of these variations should present these general features: First, every day's menu should present several things hard to chew and dry. Second, every day's menu should be rich in proteins. Third, any lunches taken in midforenoon or midafternoon should be very small in volume and should always be dry, requiring very slow mastication. The dryness will insure the slow mastication, and the slow mastication will, in turn, insure a small quantity, rapidly digested; such a lunch will not interfere with the supper that is to follow two or three hours later.

B. FOOD FOR THE ADOLESCENT

The adolescent period begins in the girl usually about the thirteenth year, and the boy usually about the fourteenth year. In both sexes the adolescent period is marked by great physical growth and development. In order to furnish the material for this physical growth, the diet for the adolescent should be very rich in easily digested proteins. There is no period in the whole life history of an individual when there is more urgent need of the materials which are used in building up red blood. This need is particularly urgent in the case of adolescent girls. Attention has already been called to the fact that lean meat is rich in iron; eggs are rich in iron; dark green leaves of vegetables are rich in iron. An adequate and rational menu for a fourteen-year-old girl and her sixteen-year-old brother would be somewhat as follows:

BREAKFAST

A cereal with cream and sugar.
Buttered toast.
Cereal coffee.
One boiled egg.
Fruit (grapes, apples, bananas, oranges, or berries).

LUNCH

A purée or cream soup with crackers or croutons.
Bread and butter.
Fruit.
Rice pudding or custard.

DINNER

An ample portion of meat.
Potatoes (baked or boiled).
Side dish of vegetables.
Fruit, stewed or canned, with graham wafers.

Note regarding this dietary, that it is not only rich in proteins, but it will be adequate to nourish an adult at moderate work. As a matter of fact, the adolescent boy or girl in school, or in the office or factory, will eat quite as much as an adult, and will be far more seriously injured if he does not get all he needs than will the adult in a similar fasting. Not infrequently a lunch of some kind is called for at half past three or four o'clock in the afternoon. In the case of a girl, if she has begun to show some signs of pallor, frequently observed in high-school girls, let her prepare for herself an egg lemonade, using two egg yolks in the place of the yolk and white of one egg. Such a lunch will not interfere with her appetite for dinner, and should result in bringing back the color to her cheeks.

The general craving of adolescents for sweets is a natural one and should be satisfied. Let them make fudge and other sweets, but, as a rule, these sweets should be eaten immediately following meal-time. When so eaten they serve an important purpose in the dietary and seldom disturb the digestion. These sweets are condensed sources of energy, and the craving for them seems to be more or less instinctive. Whatever may have been the relation between the eating of sweets and tooth decay in the times of our grandfathers, the general use of the toothbrush has robbed candy of any bad reputation which it may have possessed in this direction in times past.

C. FOOD FOR THE ATHLETE

The high-school boy of athletic tendencies needs no other food than that outlined above for the adolescent. Under this topic I would mention certain general principles to be applied to the dietary of the college athlete, who is entering upon a rigorous régime of athletic training, with a view to entering a contest. Among the things to be accomplished in athletic training are strength, endurance, and skill, with as light weight as consistent with the other requirements. Weight, represented by fat deposit, is usually an incumbrance in nearly all forms of athletic contests. For that reason athletic trainers have from early times required the contestants to work off their fat. Reference has been made in a previous chapter to an old and new régime in athletic training and in training dietaries. According to the ideas of preceding generations, loss of fat could be accomplished most effectively through a decrease in the use of water. While it is true that the reduction of the water taken into the system results in a very rapid reduction in weight, this preliminary weight reduction is due simply to a depletion of the system in water, and a very small proportion of the lost weight represents fat. If this depletion of the system is continued, there will presently begin an actual loss of fat because of a disturbance in the nutrition of the system due to lack of water. It is hardly necessary to set forth in detail the arguments against so irrational a method of reducing fat.

Another fallacy which governed our predecessors was that to increase muscular power a great increase in muscle tissue should be introduced into the dietary, so we find that the training tables of a quarter of a century ago, and even more recently, provided for the athletes a dietary in which meat in large quantities appeared three times a day. The proteins of the diet were at least three times as great in quantity as required to maintain nitrogen equilibrium. As a result, the kidneys were overtaxed in their work of excretion and the victim of the illy devised régime began progressively to accumulate in his system those mid-products of protein oxidation which in a few weeks would put him off the field for recuperation.

Since the recent researches in metabolism have exposed these two gross fallacies, a new régime has been adopted by the leading trainers and physical directors of the country. This consists in reducing the protein to an amount only slightly above that amount actually required to maintain nitrogen equilibrium.

The carbonaceous foods—fats and carbohydrates—are given in amount only sufficient to maintain the carbon equilibrium, thus insuring no loss of weight unless in the case of men who have too great a fat deposit, in which cases the carbonaceous foods are reduced below the immediate needs of the body, so that there will be a progressive reduction of fat during the training to a point where the greatest efficiency is attained. After this the carbohydrates and fats may be slightly increased to an amount which will maintain weight equilibrium. The new régime provides for the individual all the water which he needs, though it guards him against overdrinking. For a typical menu for the athlete, see above in Chapter X.

Great variations may be introduced into this menu, but the fundamental principles set forth above should always be observed.

D. FOOD FOR THE SEDENTARY

Those people who are confined indoors and whose work is largely with the brain rather than with the muscles require a diet adapted to their needs, rather than one adapted to the needs of the lumberman or the college football player. If the man who engages in almost no physical exercise indulges in a heavy diet, in which meat appears two or three times a day, he is almost certain to suffer one or the other of two rather serious nutritional disturbances. First, he is likely to accumulate a large amount of adipose tissue. Second, his excretion, especially that from the kidneys, is almost certain gradually to be disturbed, with the result that he is visited first with occasional, and later almost continuous, disabilities of rheumatic or neuralgic character. All these difficulties might easily have been avoided if he had used good judgment in his dietary. A typical menu for the sedentary man, whether professional or business man, would be the following:

BREAKFAST

Fruit.
Coffee.
Buttered toast, muffins, or gems.

LUNCH

A cream soup or purée with crackers, or
Sandwich and fruit, with a cup custard.

DINNER

Meat, gravy, potatoes.
Vegetables.
Salad.
Fruit.
A light, easily digestible pudding, such as rice pudding, chocolate pudding, bread pudding, cornstarch pudding with fruit sauce, gelatin or tapioca with fruit.

While this dinner will be recognized as a rather heavy one, we will assume that the sedentary man will eat very abstemiously of the different courses; that he will spend a full hour at table; that the dinner hour is the social hour of the family, and that jokes, anecdotes, and repartee keep the whole dinner circle in good spirits. Incidentally, let the sedentary man masticate his food very thoroughly and he will find that his menu is adequate, and that his nutrition is maintained.

E. FOOD FOR THE LABORER

As a rule, laborers work either outdoors or exposed to a temperature either considerably below 70° F. or considerably above. Men working in foundries and smelting works, stokers on steamships, firemen and engineers, are likely to be subjected to temperatures considerably above 70° F., while men working in any outdoor employment, as motormen, cab drivers, expressmen, etc., are subjected to a temperature considerably lower during the colder months of the year. In either case the laborer performs a great deal of muscular work and requires a very nourishing diet; while he does not require meat three times a day, many laborers

have meat that frequently. In sharp contradistinction to the sedentary man or student, the laborer should have a very heavy breakfast, and should have his dinner in the middle of the day rather than at night. A rational menu for a laborer would be as follows:

BREAKFAST

Bacon and eggs.
Potatoes (German fried or baked), corn bread, muffins or hot cakes.
Syrup.
Butter.
Coffee with cream and sugar.

DINNER

Meat (roasted or boiled beef, mutton, veal, or pork).
Potatoes, boiled or baked.
Vegetables (cabbage, turnips, beets, carrots, etc.).
Coffee.
Pie.

SUPPER

Cream of potato, tomato, or celery soup.
Rice with cream or butter and sugar.
Bread and butter.
Fruit, stewed.
Cake.
Tea.

It will be noted that each one of these meals is sufficient in quantity to satisfy a hungry man. Each one has a sufficient amount of hot food. The lightest of the three meals is the supper. The coffee and tea, almost universally craved by the laborer, is not likely to disturb his nervous system.

F. FOOD FOR THE OBESE

We propose at this time to discuss, not the pathologically obese, but simply to suggest rational dietary changes for those individuals who show a tendency to accumulate an amount of adipose tissue greater than is required for the best physical efficiency and for the best physical proportions.

It may be said in passing that it is futile to try to cure the tendency to collect adipose tissue by taking anti-fat drugs. In a vast majority of cases this tendency to accumulate fat is not a disease, but simply a personal peculiarity. The fat is deposited from the excess of food over and above the needs of the body. The correction of this must evidently be the result of two things working together—first, increased activity or muscular exercise; second, decreased food. The increased activity will have to be measured somewhat by the conditions. One can simply take all the vigorous exercise out of doors that he has time to afford. If he doesn't live more than three miles from his business he ought to walk that distance at least once each day. Not less than one hour of vigorous physical exercise should be taken each day.

As to the reduction of food, no definite rule can be laid down because of the great variation of the assimilative powers of different individuals. Each individual must determine for himself how great a reduction is necessary in order to bring about a beginning of reduction of weight. When the food has been so far reduced in quantity that the individual begins to lose weight, at the rate of, say, a pound a week, the point has probably been reached where the menu may be maintained and the reduction in weight continued at the rate of a pound a week until it has been reduced to the normal for that individual. After the weight has reached the normal then a very slight increase of the amount of food may be taken to maintain the weight stationary at this point.

Various programs have been adopted by people who are reducing their weight; some abstain from breakfast, some from lunch, some from both. As the person is usually a member of the family circle, and in the house during at least two meals of the day, it would seem best on the whole for the individual to appear at the table, take part in the conversation, go through the motions of eating, but actually partake of a very light diet. In the case of a business man the following menu will be suggestive:

BREAKFAST

Two slices buttered toast.
Café noir.
Fresh fruit.

LUNCH

Two cups hot water, if convenient; if not, two glasses cold water.

DINNER

Clear soup, bouillon, or a vegetable soup.
Meat, any kind, a moderate portion.
Potatoes, none.
Vegetables, any kind.
Salad: Lettuce or celery.
Tea.
Dessert: Fruit, stewed or canned.

If, after three months, following so light a diet as the one suggested above, together with an hour's vigorous exercise a day, there has been no reduction in weight, then the individual is justified in assuming that his case is a pathological one, and that the accumulation of fat is in his case an actual disease. He should consult a specialist. The several modes of treatment from a dietetic standpoint will be discussed in a subsequent chapter.

G. FOOD FOR THE ANEMIC

We propose here to discuss not the serious cases of chlorosis and pernicious anemia, but those cases of mild, simple anemia where the disturbance of nutrition is only slight, or at least has not reached the point where the specialist needs to bring his skill into action. In this stage no drugs need to be administered, as the condition can usually be corrected by a proper modification of the diet. If the general hygiene is not correct, that should, of course, also be modified. Mention has been made above of the importance of the iron-containing foods in these cases. The diet of the anemic person should have these two characteristics: it should be nourishing, and it should be easily digestible. Such a dietary as the following would be a rational one in this condition;

BREAKFAST

Eggs, two soft-boiled.
Toast.
Cereal coffee.
Fruit, fresh.

LUNCH

Purée of split peas, croutons.
Bread and butter.
Celery-nut salad, mayonnaise dressing.
Fruit, fresh, stewed, or canned.
Cake.
At 3 P.M. an egg lemonade.

DINNER

Bouillon.
Tenderloin steak or lamb chops.
Potato, baked.
Spinach, egg garniture.
Sliced tomatoes, mayonnaise.
Dessert: Custard or gelatin fruit, or cornstarch fruit, or rice, with lemon or vanilla cream sauce.

If the hygiene is correct, and if so nourishing and yet simple a diet as indicated above is digested and assimilated, there is no reason why, within a few weeks, there should not be a noticeable change in the color and general well-being of the individual. If the improvement is not noticeable within a month then the individual should consult a specialist.

H. FOOD FOR THE AGED

By aged in this connection we refer less to people who have reached a particular number of years of age than to people who have reached such an age as to have retired from all vigorous activities. Some people are aged at forty years; others are young at seventy. If one takes to the chimney corner at forty and withdraws from the strenuous activities and high tension of business and professional life, he is a candidate for the dietary régime here outlined. If, on the other hand, a man of seventy is vigorous in

body, and is still leading a strenuous life, he may continue to use the same dietary that he did when he was forty-five years of age.

The characteristic of diet for the aged should be that it is simple, easily digested, and nourishing, though the quantities taken should be very much reduced. A rational diet for an aged person would be:

BREAKFAST

Cereal, cream and sugar.
One soft-boiled egg.
One hot muffin.
One cup of coffee.

DINNER

Bouillon or vegetable soup.
Meat: Chicken fricassee, small portion.
Potato, boiled, one.
Vegetable: Cauliflower, creamed.
Fruit, stewed or canned.
Dessert: Custard.

SUPPER

Purée or cream soup.
Bread and butter.
Tea.
Stewed prunes or apple sauce.

I. FOOD FOR THE CONSTIPATED

Inasmuch as constipation is a condition that is brought about less by the diet than by other conditions, usually departures from good hygiene, we must not look upon the change of diet as an adequate treatment of these mild cases of constipation. Many cases of constipation are brought about through the failure on the part of the individual to respond to the call of nature. If this habit is begun in childhood, it is easy to see how the confirmed constipation habit would be acquired before the twentieth year. The condition is here advisedly referred to as a habit, because in so many cases it can hardly be called anything else.

Naturally, a simple correction of the diet cannot correct the condition. There must be a more or less general change in the régime of the individual. These changes, other than diet, should be in two directions: First, there should be vigorous bodily exercise. If one has already been indulging in such exercise, the change should be perhaps only in the quality of the exercise and the time. The exercise most effective in the regulation of bowel movements is that which involves flexion and torsion of the trunk, and the time most effective is before breakfast. The most important dietary changes would be the introduction of large quantities of liquids and of fruits, and a change from the finely ground flour to the coarse cereals. Fruits are most effective when taken late in the evening just before retiring, while water is most effective when taken in the morning forty-five to sixty minutes before breakfast. The rational dietary, then, for an individual who seems to have the constipation habit might be as follows, beginning the day, as prescribed in a previous chapter, with two glasses of water and fifteen minutes' exercise before breakfast.

BREAKFAST

Cereal: Oatmeal, corn meal, or wheat with cream and sugar.
Fresh fruit.
Cereal coffee.
Dry toast.

LUNCH

Soup, cream or purée.
Bread: Boston brown, whole wheat or graham.
Fresh fruit.

DINNER

Soup.
Meat, any kind.
Potatoes, any way.
Vegetables, any kind prepared any way.
Fruit, rhubarb sauce.
Dessert: Custard, gelatin, or any simple pudding.
At bedtime four figs, or six soaked prunes, or two apples.

Unless the alimentary tract is completely demoralized, it is hardly conceivable that it should not respond to this sort of a

régime by a regular normal passage of the bowels at least once in the day. The bowel activity is an involuntary reflex, yet it is possible to control its regularity in a measure. This is accomplished by going to the water-closet at a regular hour every day; the best hour, in the régime outlined above, would be immediately after breakfast. If this regularity is kept up conscientiously week after week, there will eventually be a normal response at a regular hour every morning.

If children are taught to go to the water-closet every morning after breakfast, and to make that their first duty of the day, they will be spared the inconvenience and annoyance of that form of constipation due to the habitual failure to respond to the call of nature.

Certain other forms of constipation may not respond to this régime. A person afflicted with such forms of constipation should not permit himself to get the pill addiction, but should put his case in the hands of a competent specialist.

CHAPTER XII

FOOD FOR NORMAL INFANTS

By Joseph Brennemann, Ph.B., M.D.,
Department of Pediatrics, Northwestern University Medical School

The striking thing about the newborn infant is its utter helplessness and lack of development as compared with the young of other mammals. This makes it peculiarly delicate and easily influenced unfavorably by its new environment. It is still inherently a part of its mother, for it is still dependent upon her for the only food that can safely meet its primitive needs. With this, if properly given, it will almost invariably flourish and grow at an enormous rate. If denied this natural food, it will rarely thrive as luxuriantly on any artificial food as it will on the breast. It is largely this poor adaptation to a foreign food, that is furthermore often very improperly given by the mother, which accounts for a mortality during the first year of life, that is the most appalling fact confronting us in medicine. Nearly one fourth of the civilized human race dies during the first year of life, a mortality nearly sixty times that of the fifteenth year, and only equaled again as we approach the eighty-fifth year. Directly or indirectly, the great majority of these deaths is due to nutritional disturbances that could, in a great measure, be prevented if these babies were properly nursed at the breast or were carefully fed on artificial food. In this and the succeeding chapter it will be our task to consider the cause, the prevention, and the remedy of this deplorable condition.

A. THE ALIMENTARY TRACT OF THE NEWBORN INFANT

1. **Anatomy.**—The alimentary tract of the newborn infant differs in many details from that of the adult. *The mouth* is free

from teeth until the sixth or eighth month. This naturally restricts the food to liquids for the greater part of the first year. *The stomach* at birth has a vertical position, extending from the tenth dorsal vertebra to a point midway between the lower end of the sternum and the umbilicus, the pylorus lying usually in the midline, less often to the right or to the left. This position, together with an imperfect development of the fundus, probably favors the regurgitation and vomiting that is so frequent during the earlier months. The pylorus is relatively wide in infancy and especially at birth. The capacity of the stomach has been carefully studied on both the living child and the cadaver, and has been placed at about one to two ounces at birth; two to three ounces at the end of the first month; six ounces at the sixth month; and from nine to ten ounces at the end of the first year. Too much importance has probably been given to these figures as measures of the size of single feedings in artificially fed infants, because different stomachs vary considerably in size, and in larger feedings some of the food has passed beyond the pylorus before the last of it has been taken.

The intestine is relatively larger than in the adult. This is especially true of the sigmoid flexure, which varies widely in different individuals, and is situated wholly extrapelvically. The musculature of the intestine is relatively thin, and this is probably related to the frequency of colic in infancy. Histologically, both stomach and intestine differ only in unimportant details from that of the adult.

The liver is relatively very large at birth, two and one half times that of the adult.

2. **Physiology.**—Practically all functions are present at birth, but most of them are still in a developmental and comparatively imperfect state. *The digestive ferments*, salivary, gastric, pancreatic, hepatic, and enteric, are all found, but many are very weak at first. The ptyalin of the salivary secretions, for example, is present at birth, but is not very active till after the fourth or fifth month. *The liver* secretes bile from the middle of embryonic life. The normal acid of the stomach is hydrochloric acid, as in the adult; and other acids, such as lactic acid, that have been considered normal by some, are probably always pathological. Hydro-

chloric acid not only aids in digestion, and in the coagulation of casein by rennin, but has probably a decided germicidal action.

3. **Bacteriology.**—Bacteria are found in the previously sterile alimentary tract of the newborn infant within four to ten hours after birth. As soon as the child gets milk from the breast, the intestinal flora begins to assume a definite form that is present in every infant that is properly digesting human milk. The prevailing bacterium of its so-called "physiological fecal flora" (Moro) is a "gram-positive," long, slender rod, pointed at both ends, often branching, especially in culture, giving it the name of *Bacillus bifidis communis* (Tissier). Many other varieties of bacteria occur in lesser numbers. This definite flora accounts for the uniform condition of the bowels in breast-fed infants. The predominant action is fermentative, forming gases and acids that favor peristalsis and looseness of the bowels. When any other food is given, such as cow's milk, the bacterial flora changes and becomes polymorphous and varying. The importance of this will be seen later.

B. BREAST FEEDING

The only food that meets all of the infant's requirements is human milk. This is especially true during the first few weeks of life, when any artificial feeding is often a dangerous substitute. Breast feeding should be encouraged in every way, even if only for a short time. The pessimism about increasing inability of mothers to nurse their babies is not entirely well founded. From the *consultations de nourrissons* in Paris, and from many other sources, comes increasing evidence that many more mothers would be able to nurse for many months, and nearly all of them for many weeks, if they were properly encouraged, and properly taught how to nurse, and how to care for themselves and for their babies.

1. **Human Milk.**—Human milk is a bluish white, alkaline or amphoteric, germ-free fluid, with a specific gravity of 1,026 to 1,036, with an average of 1,031 at 60° F. (Holt).

A. Colostrum.—During the first two or three days the infant receives daily only a few ounces of a secretion from the breast,

called *colostrum.* It is heavier, with a specific gravity of 1,030 to 1,040, thicker and more yellow than later milk. It contains three or four times as much proteid, about one half as much sugar, and a little more salts. When boiled it forms a thick coagulum. It contains characteristic large, irregular, granular masses, *the colostrum corpuscles,* that are four to five times as large as the larger fat globules. They are probably fat-laden leucocytes that are endeavoring to relieve milk stasis, and disappear normally during the first two weeks when the flow of milk is well established and the breast emptied at intervals.

B. Composition.—After the first few weeks human milk varies but little in composition throughout the whole period of lactation if the breasts are emptied regularly. It contains about an average of fat four per cent; sugar seven per cent; protein 1.5 per cent; salt 0.2 per cent; water 87.3 per cent (Holt). *The fat* varies most and is considered the measure of richness of the milk. It varies from two to six and even ten per cent in different individuals, and in the same individual at each nursing, the first part containing little and the last part very much fat. It is composed of the neutral fats, olein, palmitin, and stearin, with a small amount of fatty acids. It occurs as minute, round, refractive globules of fat, varying considerably in size and suspended in the form of an emulsion. Closely connected with the fat and possibly also with a protein is a phosphorus-containing body called lecithin, that is much more abundant than in cow's milk, and is probably of importance in metabolism.

The proteins consist of casein, lactalbumin, lactoglobulin, and probably others, such as lecithalbumin and lactomucin. *The casein* is a phosphorus-containing protein combined with lime and forms a little less than one half of the total protein. It is imperfectly coagulated by rennin, by acids, and by certain mineral salts, forming a fine flocculent precipitate. *The lactalbumin* coagulates on heating, but is uninfluenced by rennin. The *lactoglobulin* is found only in small amounts, except in colostrum. The proteins vary but little during lactation, falling slightly in quantity toward the end.

The sugar is milk sugar or lactose. It is the most constant food element throughout lactation as well as in different indi-

viduals, probably because of its important rôle as a heat producer in the body.

The salts are combinations of K, Na, Ca, Mg, NH_4, Fe, O, N, P_2O_5, Cl, CO_2, with traces of Fl, I, Mn, and others. They gradually lessen in amount.

Citric acid is always present in small amounts.

C. Immunizing Bodies.—Human milk contains all the antitoxins, alexins, etc., found in the mother's blood serum often in definite proportions. These are known clinically to have a decided influence in protecting the nursing infant against infections. The baby that nurses is in this respect a part of its mother.

D. Ferments.—Milk contains many ferments, such as amylolytic, possibly glycolytic, proteolytic, and coagulating ferments; lipase that has a fat-splitting action, reductases, and others. How much importance these enzymes have in nutrition is not known.

2. **Quantity of Breast Milk Required.**—The quantity of breast milk required by healthy, thriving infants has been determined by numerous observers who have weighed such babies before and after nursing, for many months in some cases. The daily amounts taken have been found to vary quite definitely with the weight of the baby, and with its age. During the first month this daily amount can be placed at one fifth to one sixth of the baby's weight, gradually lessening to one eighth after the sixth month. From such observations in healthy infants Heubner determined the number of calories per kilogram (2.2 pounds) of body weight taken daily during various parts of the first year. This so-called *energy quotient*—i. e., the number of calories per kilogram of baby taken daily—he places at 100 during the first six months, gradually lessening toward the end of the year to about 80 or 85, with 70 as approximately the energy quotient on which the child will neither gain nor lose. The caloric value of one ounce of human milk can be placed at 21.

3. **Hygiene of Maternal Nursing.**—During the first two or three days the newborn child gets only a scant supply of food, from one to three ounces daily of colostrum. No other food should be given during this time except water. It will be remembered that the "physiological fecal flora" occurs only when breast milk is taken, and any other food would establish a flora that might be

extremely dangerous to the delicate organism. It is for this reason, too, that every infant should get breast milk for a time, if only for a few weeks or even days. If the child is vigorous and has no fever (*inanition temperature*) on the second or third day, it is best to await serenely the free flow of milk that commonly occurs on the third or fourth day, rarely later. If there is fever, or the milk is delayed beyond this time, or the infant seems weakly, it is necessary to give temporarily some food, preferably milk from another mother, or a weak cow's milk mixture, or a five-per-cent milk-sugar solution.

Intervals between Nursings.—The baby should be put to the breast quite regularly from the first day, both to accustom it to nursing and to stimulate the breast to free secretion. After the first two or three days, two-hour intervals between nursings have usually been recommended, and still are by many authorities. The only justification for this seems to be that the stomach capacity of the newborn baby has been found to be only one to one and a half, or at most two ounces, and it would manifestly be impossible for it to take its necessary twelve to eighteen ounces of milk a day unless fed so frequently. If, however, the baby is allowed to sleep as long as it will, it rarely wakes up to demand food as often as every two hours, unless it already has some digestive disturbance due to too frequent feeding, and will more commonly go three to five hours, as obstetrical nurses well know. If it is now weighed before and after nursing after so long an interval, it will be found that it can take, without discomfort or regurgitation, a greater quantity than its stated stomach capacity. This does not subject it to danger of distention, because enough of the milk has found its way beyond the pylorus before the feeding is completed, and in the infant gastric digestion is relatively unimportant. An ordinary breast feeding leaves the stomach empty at the end of one and a half or two hours; a larger feeding requires a longer time. If the baby is fed again at the end of two hours there is no time for the formation of free hydrochloric acid, which is on the one hand a very important physiological check on bacterial growth in the stomach, and on the other hand acts as a stimulant to the secretions of the liver and the pancreas (Pavlow). Three hours would certainly seem logically the minimum

interval. More important than any theory is the fact that babies cry less, sleep more, are happier, have less colic and indigestion that is often interpreted as hunger, and gain as much or more when fed on an average of every four hours than when fed every two or even every three hours. One long interval of eight hours at night can usually be instituted at the start, or at least very early. It is especially easy to begin this régime at the start, when the baby sleeps almost constantly, and the mother can see how well it works, as compared, as is often observed, with a former baby that was fed every two hours, and was colicky and restless, and, perhaps, finally deprived of the breast altogether because "the milk did not agree with it." At a later time, when the baby is "spoiled," and has been accustomed to the two-hour interval, it is harder, but even more indicated, to get the coöperation of a mother who thinks her baby is "hungry even now." Not the least benefit comes to the mother herself, and so again to the baby, on account of the greater liberty and more rest and sleep, for an overworked, anxious mother with a fretful baby is a poor nurse. If the child oversleeps there is no occasion to waken him, and he will soon demand his food quite promptly at about the accustomed time.

The length of time of each nursing usually can be left safely with the normal baby. It nurses till it is through and drops off, requiring from five to twenty minutes, depending upon the vigor of the baby, the amount of milk, and the freedom with which it flows. It should not commonly be roused to renewed efforts, simply because it has nursed only five or ten minutes. Overfeeding, vomiting, and indigestion can thus be easily induced. Normally, a child gets the greater part of a twenty-minute nursing in the first five minutes. If in doubt, the scales will readily decide whether it is getting enough. *Only one breast* should be given at a feeding, and the breasts alternated in successive feedings, except possibly during the first few days, and in weak babies, who are not yet strong enough to get the last of the milk, and in overfed babies, where it is desirable to give only the weakest milk and get the breast to secrete less voluminously. If this is not done the child will soon learn to leave the first breast when the milk begins to come hard, and so the breast remains unemptied,

and the greatest stimulation to milk secretion is omitted, with the natural result. For the same reason one breast should not be used more than the other, because of sore nipples in the latter, or because it seems to have less milk.

The nipples should be washed with boiled water before and after nursing. The danger from fissures and sore nipples, and so of inflammation of the breast, is greatly lessened and their cure greatly facilitated by the longer intervals between feedings.

The washing of the baby's mouth is best omitted altogether. It is not only ineffective, but the mouth cleanses itself, and thorough washing frequently causes ulcers in the roof of the mouth, and other abrasions of the delicate mucous membrane that form a favorable site for thrush.

Water should be given freely from a spoon until the baby nurses well; after that, from a bottle several times daily throughout the whole period of maternal nursing. If it gets an abundant supply of milk, it needs but little water, but the bottle should be given nevertheless, to accustom it to that method of taking food. If this is not done, the baby will often refuse to take a bottle at all after the sixth or eighth month, when weaning is begun. To feed a well baby of that age from a spoon or a cup is very unsatisfactory, and in case of sickness it might prove a serious handicap.

The mother should lead her usual life, avoiding all extremes of excitement and exertion, and should get enough outdoor exercise and an abundance of sleep.

Her diet should differ in no way from that to which she is accustomed. It should be well balanced, nutritious, varied, and abundant, because she is nourishing two. The restrictions in diet so common in nursing mothers are not only useless, but even harmful, because the monotony of the diet often destroys her appetite. Equally objectionable is the forced feeding to which mothers with fine blooming babies so often subject themselves.

4. **Conditions that Affect the Mother's Milk.**—(*a*) *Nervousness, worry, grief, insomnia, an erratic temperament,* have a decided influence on the milk supply, and so on the baby. Erratic, nervous mothers will often have an abundance of milk one day and very little the next day, and the milk often leaves " all at once."

(*b*) *Diet.*—The variations that can be produced in milk by diet are very limited, and of little therapeutic value.

(*c*) *Menstruation* apparently lessens the amount of milk, and so affects the baby in a small percentage of cases. It rarely is an indication to make any change in the regular order of nursing.

(*d*) *Pregnancy* often lessens materially the quantity of milk and possibly affects the quality, and then makes weaning desirable. It rarely occurs early in lactation, so weaning offers little difficulty.

5. **Contraindications to Nursing.**—*Absence of milk,* and some *deformity* like inverted nipples that makes nursing impossible, are the only absolute contraindications. *Tuberculosis* is almost equally so. *Syphilis* is only a contraindication if the baby is free from it. In such conditions as anemia, nephritis, puerperal infections, mastitis, one must weigh all the circumstances. If the mother has an acute contagious disease, it is often safer to let the baby nurse—e. g., in measles, mumps, diphtheria, and even scarlet fever—than to subject it to the dangers of artificial feeding under unfavorable circumstances.

6. **Weaning.**—There is no definite time at which a mother should stop nursing her baby, and weaning should always be very gradual, whenever possible (see mixed feeding). It is not best to feed a baby exclusively at the breast beyond the eighth or tenth month, even though the milk is abundant. Babies so fed commonly get pale, soft, less well nourished, probably because human milk contains too little iron for this period (Bunge). It is rarely desirable to continue breast feeding much beyond the first year, though many Oriental mothers nurse three and even four years. If weaning is sudden, the child should be placed at once on a small amount of modified cow's milk that is gradually increased to the necessary amount.

7. **Additional Food During the First Year.**—The eighth or ninth month is about the average time when additional food should be given the healthy infant. Orange juice or other fruit juice can be given once or twice a day, about an hour before a feeding, gradually increasing from a teaspoonful to two tablespoonfuls a day. Beef juice, meat broths, or, better still, a little later, strained vegetable soup, can be given in increasing amounts up to four to six ounces a day. Rusk, zwieback, crackers, can be given in small

amounts at the ninth month, and gradually increased. By the end of the first year the healthy baby should be able to have, further, well-cooked and mashed spinach, carrots and cauliflower; thoroughly cooked cereals, oatmeal, rice, wheat, etc.; a little crisp bacon, a bone to gnaw; baked apple or scraped raw apple; an occasional egg, bread and milk, etc. Four feedings a day is ample. At each meal the child can have its bottle or the breast, with some additional food as indicated. Nothing should be given between meals except water and the fruit juices.

8. **Normal Development of the Breast-fed Infant.**—By the end of the fifth month the birth weight, seven to seven and a half pounds, is usually doubled, fourteen to fifteen pounds, and by the end of the first year trebled, twenty to twenty-one pounds. This means an unbroken gain of five to eight or more ounces a week during the first few months, and two to four ounces a week the last few months, with an average weekly gain of four ounces. The average birth length of 20.5 inches increases about eight inches during the first year. The first teeth appear at the sixth or seventh month, and there should be six at the end of the year.

9. **Feces.**—During the first two or three days the baby has five or six greenish-black, tarry bowel movements, the so-called *meconium*, made up of swallowed amniotic fluid, intestinal secretions, epithelial cells, bile, etc. After this time they begin to turn yellow, and in a few days have their normal properties. The stools are then two or three in number daily, of a rich gold or egg-yellow color, are soft and mushy in consistency, acid in reaction, and have a slightly acid, not unpleasant odor. The gases present are hydrogen and CO_2, and so are nearly odorless. The feces are composed of water, and solids made up of ten to thirty per cent fat, fatty acids, and soaps; about eight per cent salts; mucus, bile, epithelial cells, and intestinal secretions; and over fifty per cent bacteria. Quite frequently they contain an excess of mucus, and many fine, soft, yellowish curds, and are slightly green in color. Unless the baby shows other evidence of a food disorder, such bowel movements need give no concern, as they are quite consistent with normal development.

10. **Wet Nursing.**—Under ideal conditions this is a nearly perfect substitute for maternal nursing. The nurse must be found to

be healthy in every way, and tuberculosis, gonorrhea, especially if she is to nurse a female child, and syphilis are to be most carefully excluded. For the latter, the baby is by far the most important guide, as the mother will rarely show evidence of the disease, while the baby nearly always will after the first few weeks (Colles' Law). Her own baby, furthermore, is the best index of the nurse's ability to furnish an abundance of milk. She should be neither too young nor too old. A multipara is commonly preferable, because she has demonstrated her efficiency before. The age of her baby, as compared with that of the baby she is to nurse, is a matter of slight, if indeed of any, importance, except that one prefers to avoid the first month or two of lactation because of the possibility of syphilis. An examination of the milk is rarely of any practical value. The nurse should usually have her own baby with her, for the baby's sake, and to keep her from worry and lonesomeness, and also to make sure that the breasts are well emptied, so as to keep up a good flow of milk. If the babies differ in size and vigor, the breasts should be alternated so that both will be stimulated alike. If she is to pump or press out her milk, she must have her baby with her, because the breasts cannot be sufficiently emptied normally to keep up the necessary flow.

C. MIXED FEEDING

If the mother does not have enough milk properly to nourish her baby, one or more breast feedings can be replaced each day by a bottle. Under careful control by weekly weighing, this substitution can often be carried on very gradually, and the baby still kept on the breast for weeks and even months. One nursing after another is replaced by a bottle, the latter given as far apart as possible, until finally the mother is unable to give even two feedings a day, using both breasts each time. Nursing should then be stopped. The common custom of giving the baby the breast finally "only at night," when the baby should be asleep, is evidently objectionable. Unless it is desirable to wean the baby, the method of giving the bottle after each feeding is to be condemned. The baby quickly prefers the easy-flowing bottle to the breast, and

the latter is neglected often very rapidly. Less milk is secreted, as a consequence, nursing is still more unsatisfactory, and the baby soon refuses the breast altogether. In either method a nipple should be used from which the milk comes with considerable difficulty.

D. ARTIFICIAL FEEDING

The only substitute for breast milk that contains in any degree the same properties is the milk of some other mammal. No other fat or protein can take the place of that of milk. The milk of each kind of mammal is peculiarly adapted to its own young, and not to that of another kind. To overcome, as far as possible, this unfitness for the infant of cow's milk, which was intended for the calf, is the main problem of artificial feeding.

1. **Cow's Milk and Human Milk Compared.**—Breast milk flows slowly, after proper effort, warm, living, non-acid and germ-free directly into the baby's mouth. Cow's milk is drawn into vessels, and stands for hours, even days, before it is given to the baby from a bottle. It becomes decidedly acid in reaction, teems with bacteria, is either kept cold, or else is heated so that its living properties, ferments, etc., are destroyed. It has a different chemical composition, a different physiological reaction with rennin, and has no antitoxins that are of value to the baby. Over and above all these differences there are, doubtless, others that are equally or even more important, that make up the difference between a food that is a specific and one that is a substitute.

Composition.—The following table from Holt shows at a glance the comparative average composition of human and cow's milk:

	Human Milk.	Cow's Milk.
Fat	4%	4%
Sugar	7%	4.5%
Proteids	1.5%	3.5%
Salts	0.2%	0.75%
Water	87.30%	87.25%
Total	100.00%	100.00%

The *fat* of cow's milk is apparently chemically much the same as that of the breast milk, but contains more volatile fatty acids and less lecithin.

The *sugar* is identical in both, but less abundant in cow's milk.

The *proteins* offer the most striking difference, cow's milk containing two or three times as much as human milk. The latter contains rather less casein than soluble proteins, lactalbumin, lactoglobulin, etc., while cow's milk contains five or six times as much casein as lactalbumin. As a result of this difference in casein content, cow's milk, when mixed with rennin, or gastric juice, forms a jellylike, thick, semi-solid coagulum that contrasts strikingly with the fine, soft, flocculent precipitate of human milk treated in the same way. If similar conditions prevailed in the stomach, the baby fed on cow's milk would get a semi-solid food, that fed on human milk a liquid food. It is not difficult to see why casein has been considered *the* important disturber in the infant's digestion of cow's milk, especially when curds in the bowel movements are an almost unfailing accompaniment of milk indigestion.

The *salts* are relatively more abundant in cow's milk, especially the calcium and sodium salts. Breast milk is richer in iron and potassium salts.

A comparison of the chemical composition of the two milks in our present state of knowledge gives us very little light on the great difference in their actions on the baby. The *fat,* in spite of great chemical similarity, is well borne in breast milk, and yet offers the most trouble of any food element in feeding cow's milk. The *protein,* on the other hand, with its decided chemical and physiological differences, seems to offer the least trouble of any food element, both in digestion and metabolism (see next chapter). The part played by the *salts* in this connection is imperfectly understood, but probably not important. It would be a simple matter to mix cream, milk, whey, water, and milk sugar so that the mixture would very closely approach the chemical composition of breast milk, and yet its action on the baby would be vitally different in most cases. Our aim, then, in adapting cow's milk to an infant, is not to make it like human milk, but to make it *act* like it as a food. While our food mixtures often

bear little resemblance to breast milk, we nevertheless always keep in mind its composition as our standard and depart from it only so far as the difference in digestibility and assimilation of the different food elements of cow's milk makes it necessary to do so.

2. **Adaptation of Cow's Milk to the Healthy Infant.**—WHOLE MILK.—The use of straight cow's milk has been enthusiastically advocated by some French and a few German writers. It is apparently well borne by some babies almost from the start, provided the amount is strictly limited and overfeeding avoided. Thus Budin recommends one tenth of the body weight daily of milk, and reports excellent results, "in infants after the fifth or sixth month, weighing thirteen to fifteen pounds." Nearly all of his babies are fed at the breast, however, for the first few months. Practically all other writers agree that the milk should be diluted and otherwise modified, at least during the first few months.

MODIFIED COW'S MILK.—The most primitive and most effective modification is dilution with water. A dilution of one part of milk with two parts of water is commonly well taken from the start. This reduces the protein to about the amount found in breast milk. It is *the* indispensable food element, as it alone contains nitrogen, and so should not be given for any length of time in less amount than in the natural food. To the twenty-four-hour food from one half to three quarters of an ounce of milk sugar is added to make up for the deficiency caused by dilution and to approximate the seven per cent found in breast milk. The proportion of milk is gradually increased, that of water lessened, and the amount of sugar increased, so that by the end of the first or second month the baby is getting equal parts of milk and water with the addition of three quarters to one ounce of milk sugar, giving a total of five to seven per cent of the latter. On this the child can be left for a long time. The same process is then continued until near the end of the first year the child is on whole milk. The sugar is gradually lessened, as more milk is added, and omitted when we reach straight milk. Cereal waters, or gruels, made up of barley, rice, wheat, or oatmeal flour, often seem of advantage from the start as diluents in place of plain water, but they should be used with caution till after the fifth or sixth month, when the ability to

digest starch is well developed, and they should regularly form a part of the food. The additional food during the latter part of the year has been discussed under maternal nursing. The total amount of the twenty-four-hour food mixture is about a pint at the beginning, gradually increasing to a quart in the second half year. This amount need rarely be exceeded to any extent. Cane sugar is recommended by some (Jacobi) and malt sugar by others, in place of milk sugar. The latter is given preference here largely because it is the sugar of human milk.

Feeding Intervals.—Long intervals between feedings are indicated here still more strongly than in breast feedings. Cow's milk leaves the stomach more slowly, an ordinary feeding requiring at least two and a half, and more commonly three hours, a large feeding even longer. Three hours would seem, theoretically, a minimum interval, and four hours a better average interval between feedings. Experience has amply confirmed this theory in practice.

Quantity of Milk.—The quantity of milk given during the twenty-four hours is even more important than the strength of the food. *Overfeeding in general, or with one or the other food element, is the greatest factor in the production of nutritional disturbances in infancy.* The prevention of overfeeding is, therefore, of the greatest importance in feeding babies. One must *watch* them carefully for the *evidences of overfeeding* that are commonly easily recognizable (see next chapter). Not the least of these is too rapid a gain in weight. A gain of eight to twelve ounces a week, in artificially fed babies, is not a thing to be proud of, but rather to be considered and heeded as a warning. Of very great value, further, in all cases, and especially in those that cannot be watched carefully, are certain *numerical measures of food requirements* that serve as approximate guides to the amount of food to give healthy babies. Thus it has been found, when using such dilutions and modifications as above recommended, that the *amount of milk* in the twenty-four-hour mixture, taken by healthy, thriving infants, usually lies between one and one and a half ounces per pound of baby, with an average of about one and a quarter ounce. The first amount is commonly too little to gain on properly, and distinct evidences of overfeeding usually arise before the maxi-

mum amount is reached. We would expect, then, to find a normal infant of twelve pounds to be taking between twelve and eighteen ounces of milk in its twenty-four-hour mixture, with an average amount of about fifteen ounces.

Calorimetric Control.—Equally useful and applicable to all kinds of food mixtures is a calorimetric control advocated by Biedert, and elaborated and popularized by Heubner, of Berlin. Heubner found that normal thriving breast-fed babies took about 100 calories per kilogram of body weight daily during the first few months of life; that after the sixth month this so-called energy quotient gradually sank to 80 or 85 at the end of the first year; and that 70 was the approximate energy quotient on which a baby would neither gain nor lose. Experience has proved these figures to be of immense practical value, as indicating the maximum amount of food that an infant should be allowed to have. *They should be used—and this applies equally well to the milk-volumetric guide above—as a check on overfeeding and underfeeding, and not as an advance measure of the amount to give.* They tell us not how much to give so much as how much *not* to give, and apply only to well babies, and are used only as an adjunct to careful clinical control. *We have not, then, a system of infant feeding, but a valuable aid in infant feeding.* By keeping tab on an infant's energy quotient, we can, on the one hand, be warned when we are approaching or exceeding an amount that usually gives evidence of overfeeding; and on the other hand, we can prevent an all too frequent condition of prolonged unrecognized underfeeding on a cereal water, or skimmed milk, or other mixture of low food value.

The practical application is very simple. It is only necessary to remember the caloric value of one ounce each of the usual ingredients of food mixtures, and from these and the baby's weight to calculate the energy quotient. Thus the caloric equivalent of one ounce of cow's milk, or human milk, may be placed at 21; of sixteen per cent cream at 54; of fat-free milk at 10 or 11; of sugar at 120; of flour at 100; of barley water (one ounce to the quart of water) at 3; of "baby foods" at about 110. If a baby of ten pounds gets milk, 12 ounces; barley water, 16 ounces; milk sugar, 1 ounce, the energy quotient is calculated as follows:

Milk	$= 12 \times 21 = 252$ calories.	
Barley water	$= 16 \times 3 = 48$ calories.	
Milk sugar	$= 1 \times 120 = 120$ calories.	
Baby's weight	$= 10\overline{)420}$	total calories in food.
	42	No. of calories per pound = energy quotient.
	2.2	
	84	
	84	
	92.4	No. of calories per kgm. = energy quotient.

The energy quotient is, of course, equally well expressed in calories per pound, and our figures corresponding to 100, 80, and 70, would be 45, 36, and 32. The former is retained because it is commonly used in the literature on the subject.

After a little experience this calculation can be made in simple mixtures without paper and pencil, and after a time the energy quotient can be estimated very closely at a glance. In such mixtures as here advocated, it will be found that the calorimetric and milk volumetric guides run quite parallel.

In feeding a baby on cow's milk for the first time, it is always best to begin with a small amount and gradually, under clinical control, proceed to a satisfactory amount of food. For example, a normal, well baby of twelve pounds is to be fed artificially. Five feedings of six ounces each would seem an appropriate amount for each twenty-four hours. We might start with milk ten ounces, barley water twenty ounces, milk sugar one half ounce, and watch the result. The milk and sugar can then be increased gradually, depending upon how well it agrees with the baby, until at the end of a week or so the child is getting, say, milk, fifteen ounces; barley water, fifteen ounces; milk sugar, one ounce. This seems to agree with the baby, and from a milk standpoint (one and a quarter ounces to a pound), and from a caloric standpoint (e. q. = 88), we feel satisfied and wait for a week to see if it gains. If it gains four or five ounces and seems well in every way, we leave this food unchanged until the gain is no longer satisfactory. Then we slowly increase the food again all the more cautiously, because we are approaching figures that we have learned to regard as warnings.

Care of Milk.—Milk procured and kept under favorable conditions will remain sweet for many days. The essential

points in procuring a milk that is safe for infants are the following:

(*a*) Utmost cleanliness, asepsis and antisepsis about milking, stable, cows, udders, hands, pails, bottles, nipples, etc.

(*b*) Rapid cooling of the milk to a low point, and keeping it constantly on ice, thereby inhibiting the growth of bacteria.

(*c*) The interval between milking and final consumption should be the shortest possible.

(*d*) The cows should be healthy, and tuberculosis should be excluded by the tuberculin test.

STERILIZATION.—If milk can be obtained that meets all of the above requirements, we commonly give it raw. If not, the question of sterilization arises. This can be either fairly complete by boiling for five minutes or longer, or partially by pasteurizing—i. e., heating the milk from 150° to 165° F. for twenty to thirty minutes. Boiling produces chemical changes, such as a partial coagulation of lactalbumin, conversion of some milk sugar into caramel, etc., and destroys ferments, and possibly other living properties, and so is thought by some to lessen the nutritive value of the milk. Pasteurization kills practically all pathogenic germs, and nearly all others, and does not bring about such chemical changes. The latter, therefore, seems the preferable method, but it is more complicated, and is less safe in other than intelligent hands. There is very little, if any, conclusive evidence that boiling the milk lessens or changes its nutritive value, except that in a very small percentage of cases scurvy will occur (see Infantile Scurvy). Even this is open to question, because in France, for example, practically all milk is boiled for a long time, and yet scurvy is almost unknown (Budin). In many cases boiling the milk seems to make it more easily digested. That it favors the production of rickets is hardly tenable. Until we are better convinced that sterilization is more injurious, and as long as we are taught that it is quite possible that a good deal of our tuberculosis is acquired through milk in infancy, it would seem a wise precaution to boil, or pasteurize, all milk that is not safe from that standpoint—i. e., from cows that have recently given negative tuberculin tests.

3. **Growth and Development on Artificial Food.**—Under favorable conditions this may be in no way inferior to that of breast feeding. Usually, however, progress is less rapid and sure, and serious digestive and nutritional disturbances are more frequent. In many, serious difficulties are encountered throughout, especially during the first few months. Gain in weight is apt to be slower at first, and more rapid toward the end of the first year than on breast milk. Symptoms of rickets are more frequently present, and dentition is commonly delayed.

4. **Feces.**—One must never expect to see the gold-yellow, mushy, slightly acid bowel movement of the breast-fed child. The movements are always less frequent—one, or at most two, a day; are harder and dryer, commonly "formed," alkaline in reaction, and of a paler yellow color, with a stronger, more cheesy odor. An acid odor with increased frequency is pathological. Carbohydrates, especially malt sugar, give the bowel movement a browner color. The bowel movement of fat-free milk is homogeneous, smooth, brownish, like hard vaselin. When other food is added late in the first year, the bowel movements approach in every way those of the adult.

5. **Feeding During the Second Year.**—During the early part of the second year four feedings a day, later three, are a sufficient number with fruit juices before one or two of the meals. Milk should be given at each meal, not to exceed a quart a day, and often a less amount is preferable. The rest of the food may be made up during the first few months of rusk, zwieback, dry toast, vegetable soup and broth, well-cooked cereals, fruit juices, baked or scraped raw apple, an occasional soft-boiled or poached egg, well-cooked and mashed spinach, carrots, and cauliflower. From these a well-balanced diet may be chosen to suit the circumstances, all new additions being made very cautiously. Later in the second year scraped beef or finely divided rare roast beef, steak, lamb chop, or chicken, a little baked or mashed potatoes, a little of some of the heavier vegetables, such as peas, lima beans, head lettuce, asparagus tips, cornstarch pudding, custards, etc., may be added to the diet. Milk may be given from a cup, if it is well taken. This is frequently not the case, and there is no objection to the child's taking its bottle throughout the year, either directly be-

fore or after, or with the other food. He will commonly take more milk from a bottle and fall off to sleep better than if it is given from a cup.

6. **Other Substitutes; "Baby Foods."**—The very extensive use of these so-called " foods " warrants their brief discussion. For our purpose they may be divided into two classes:

I. Those that are advertised as complete foods in themselves and contain milk.

II. Those that are to be used only in conjunction with fresh milk, and are so advertised.

In the *first class* are the sweetened condensed milks, the malted milks, Nestle's food, etc. Condensed milk is milk evaporated to about one fourth of its volume with the addition of about forty per cent of cane sugar. In the others the milk is evaporated to dryness, and sugar and partially or completely dextrinized flours are added. In the malted milks the predominant carbohydrate is malt sugar; they are all deficient in fat and fresh animal proteids, and contain an excess of carbohydrates. Many infants apparently thrive on them alone for some time, but are always less immune and resistant to infections, and practically invariably, if fed on these alone for a long time, will show decided evidence of rickets, often of scurvy, and other nutritional disturbances.

In the *second class* belong such malted foods as Mellin's and Horlick's, that are composed chiefly of dextrins and maltose, especially the latter; the farinaceous foods, such as imperial granum, Ridge's food, Robinson's patent barley flour, etc., that are composed largely (about 75 per cent, Holt) of unchanged starch; Eskay's albuminized food, made up largely of dextrins, dextrose, and lactose (67.81 per cent, Holt); and starch (21.21 per cent, Holt). They take the place of the simpler carbohydrates, barley, oatmeal, sugar, etc., over which they have few or no advantages. The malt preparations are useful when malt sugar is desired rather than milk sugar or cane sugar. The farinaceous preparations form a convenient transition either in the milk, or as a porridge, to the cereals. The chief objections to these " foods " are the price; the use of the word " food," that leads the uninformed to think of it as the important part of the mixture and not the milk; the

questionable claim that they have some special virtues as milk modifiers; and the directions which go with them that assume that all babies of a certain age are alike, and that the mother (for they are advertised to the laity) and a printed page alone can meet one of the most complex problems in medicine.

PART FOUR

DIET IN DISEASE

CHAPTER XIII

INFANT FEEDING IN ABNORMAL CONDITIONS

By Joseph Brennemann, Ph.B., M.D.,
Department of Pediatrics, Northwestern University Medical School

The infant is a peculiarly delicate organism that responds more quickly to nutritional insults than the adult. On the breast the disturbances are rare, comparatively unimportant, and easily remedied. On any substitute food the reverse is true, and under existing conditions the mortality is nearly ten times as great during the first year. This mortality is directly proportional to the ignorance and poverty of the parents, therefore to lack of care of the baby and its food, improper food and methods of feeding, poor hygiene, etc. Under favorable conditions this mortality but little exceeds that of breast feeding.

A. NATURE AND CAUSE OF NUTRITIONAL DISTURBANCES

The nutritional disturbances that occur during infancy are manifold, varying all the way from slight discomfort, vomiting, and other evidences of indigestion, to the severest intoxications, such as cholera infantum. With the advent of bacteriology it became evident that many of these disorders, especially those accompanied by fevers and intoxications, closely resembled the infections that were known to be due to bacteria. This view was further supported by the fact that nearly all of these conditions occur most readily when cow's milk is given, and are rare at the breast. The former teems with bacteria, " spoils, turns sour," etc., while the latter is practically sterile. It was easy to believe that the severer cases with fever and intoxication were due either to direct

infection of the mucous membrane of the gastro-intestinal tract, or to bacterial activity with the formation of toxins in the milk, either without or within the body. The simpler, milder cases without fever and intoxication seemed easier to explain on the basis of purely food disturbances, irritation due to an excess, or too great concentration of one or the other food elements. The imperceptible shading of the mildest into the severest conditions made it hard to know where to draw the line between infection and food irritation. The absence of pathological lesions in the intestinal mucosa in so many of the severest intoxications made it evident that even here there was at least not an invasion of the intestinal wall itself by bacteria, as, for example, in dysentery, or ileo-colitis, where there is undoubtedly an infection of the mucous membrane, and where there is, moreover, a specific bacterium that causes it. The fact, furthermore, that intoxications yield almost immediately when all food is discontinued, and reappear when it is given again too quickly, while ileo-colitis is practically uninfluenced by this procedure, naturally raises the question whether in the former we have not a condition due to food alone, and in the latter one due to bacteria.

The present tendency is to attribute more importance to food itself as the disturbing factor in these disorders, and a decidedly less important rôle to bacteria, except, of course, in ileo-colitis. This change of attitude is mainly due to the epoch-marking work of two men, Czerny of Breslau, and Finkelstein of Berlin. In a series of papers on " Alimentäre Intoxication " in the *Jahrbuch für Kinderheilkunde* during the past two years, Finkelstein has demonstrated, it seems quite conclusively, that these intoxications, such as cholera infantum, and the prodromal stages, dyspepsia, etc., that lead up to them, are due purely to food—that is, to a disturbance in metabolism, and not to bacteria. They are thus related to such conditions as uremia and diabetic coma, rather than to ileo-colitis or typhoid. The work of Czerny has prepared us for accepting this view. In their great work on infant feeding Czerny and Keller have shown that the nutritional disturbances, due to the different food elements are due to metabolic conditions and are not simply indigestions nor infections. In the present discussion we will accept these conclusions, and will consider the

diseases commonly classed as indigestions, or dyspepsias, entero-catarrh, or catarrhal enteritis, gastro-enteric intoxication (Holt), or alimentary intoxication, or summer complaint, or summer diarrhea and cholera infantum, as due to food itself—i. e., they are essentially digestive and metabolic disorders, and not due to infection of the mucosa, nor to action of bacteria upon food itself. Ileo-colitis will be treated separately as essentially an infectious process.

B. NUTRITIONAL DISTURBANCES DUE TO FOOD

These disorders are caused by too much or too little food, or too much or too little of one or more of the different food elements. Of these, overfeeding is by far the most important, and the fat and carbohydrates are the important disturbing elements. It is the recognition of the rôle that individual food elements play in the production of disorders of nutrition that has placed infant feeding on a really scientific basis. For this we are indebted above all others to Czerny and to Finkelstein, and their work forms the basis for that part of our discussion. We will consider first the disorders produced in breast-fed babies by overfeeding and underfeeding; then the nutritional disturbances that are produced when individual food elements are fed in excess; then the food intoxications with their prodromal stages; and, finally, the more remote but equally distinctive disorders, scurvy and rickets.

1. Nutritional Disturbances in Breast Feeding.—(*a*) Overfeeding.—This occurs especially during the first few months before the baby and the breast have become adapted to one another. The baby gets either too much milk at proper intervals, or, more commonly, too much at too frequent intervals, or else its tolerance for fat is lower than normal. Regurgitation and vomiting are commonly the first symptoms. Occurring immediately after feeding, it may be considered a physiological process of getting rid of an excess of food. Sooner or later it comes on some time after nursing, and is then part of a dyspeptic condition that manifests itself further, if unchecked, in undigested, curdy, greenish, slimy, sour, and irritating bowel movements that are greatly increased in frequency. With this there are discomfort and restlessness, shown

even in the short intervals of sleep by the drawn, anxious, twitching face. The child seems hungry, sucks its fingers, and eagerly looks for the breast, that is only too often given still more frequently. Periods of colic that are exceedingly painful and cause the child to draw up its legs and scream pitifully, occur as a result of increased gas production and distention of the intestines, making it difficult and painful for the gas to pass on. The buttocks are excoriated, often ulcerated. Thrush is apt to appear in the mouth. Eczema of the cheeks, scalp, and body is common. The child becomes pale and flabby and loses in weight. Fever and intoxication naturally follow in severe cases, unless the condition is relieved. The fat is, doubtless, the chief disturbing element.

Treatment.—In mild cases simple lengthening of the feeding intervals to four hours is all that is necessary. In more severe cases it is also necessary to reduce the amount of food taken at each feeding by limiting the time of each nursing, or by allowing the child to take a limited amount from both breasts at each feeding so as to get only the first weaker milk. Five, or even three, minutes may be long enough for a time until the child and the breasts become adapted to one another. This is commonly not a great hardship, as the baby normally gets the greater part of a twenty-minute feeding in the first few minutes. The scales will be of great service, both to determine the baby's condition and to find out how much it is getting. In the still severer cases that are accompanied by intoxication, the child is best taken from the breast for twenty-four, or even forty-eight hours, and then returned to it with short feedings and long intervals. During this time the baby must be given water freely, or barley water, or albumin water, without sugar, and the breasts must be emptied at regular intervals with a breast pump or by hand pressure. Colic is best relieved at the time by laxative enemas. The mother should lead an active, healthy life with outdoor exercise, should not eat excessively of rich fatty foods and meat, and should drink water freely. Examination of her milk is unfortunately rarely of much practical value. If the above measures fail, it is then best to substitute daily for a time one or more breast feedings by artificial food, containing little or no fat, such as modified skimmed milk, malt soup, or malted milk. As the child and breast become

better adapted to one another, these can often be discontinued again.

(*b*) Underfeeding.—This occurs if the mother has an inadequate supply of milk, or, more rarely, if it is of poor quality. There is, naturally, no evidence of indigestion, and yet a failure to gain normally in weight, or, what is far more serious, an actual loss. A very suggestive symptom is constipation, that is rarely due to any other cause in breast feeding. The baby is commonly quiet and "good," often "too good," and may become listless and apathetic. If the lack of food is marked, it finally becomes pale, inactive, weak, cool to the touch, emaciated, with soft and sunken abdomen, and depressed fontanelle, and may not nurse or even swallow when food is introduced into the mouth. The bowel movements may become brownish or greenish-brown and slimy-looking, as in infants on a simple water diet. The size and firmness of the breasts are not influenced by nursing as they should be. The baby often nurses quite indefinitely, or only a short time, and then cries because it is not satisfied. Excessive crying and apparent hunger are far more characteristic of overfeeding than underfeeding.

Treatment.—The scales will quickly decide whether there is a deficiency, and how great it is. In all but the mildest cases, and especially if the child is losing, other additional food must be given at once, either from another breast or from a bottle. As the child gets stronger and nurses more vigorously, and the mother becomes less worried and stronger in the early cases, the bottles can often be discontinued, or lessened in number. In the severest cases, when the child will no longer nurse or even swallow, the demand for food is urgent, and the use of the stomach tube for feeding will often quickly restore the child to a condition in which it can resume nursing. In the less advanced cases, with simply inadequate gain in weight, we can often wait to see whether improved conditions will not remedy the matter. The mother must be relieved of worry and of lack of sleep. She should be placed in as good physical condition as possible, she should get out of doors, and perhaps take a tonic, that her appetite may be stimulated so that she will take an abundance of milk and other nutritious food. The very common forced feeding beyond the natural

appetite, as well as the innumerable "milk producers," such as malt, beer, tea, cocoa, corn meal and oatmeal gruels, sea food, electrical stimulation, massage, and special drugs, are all of doubtful value. *The only sure stimulant to milk secretion is the regular thorough emptying of the breast.* If another more vigorous baby can also be put to the breast for a time, especially during the first few weeks, it will often establish a free flow. If this is not feasible, we must aim to build up our baby, as indicated, so that he can do this himself. If this is not successful, mixed feeding must be continued, or wet nursing, or gradual weaning, and finally artificial feeding alone is inevitable.

(*c*) Poor Adaptation to the Mother's Milk.—There are, apparently, a few babies who have an idiosyncrasy against their mother's milk, or to that of one wet-nurse, and yet will thrive on that of another. Our knowledge of these cases is very meager. Probably many of them belong in the class of overfeeding, or even underfeeding. If not, a change must be made to another nurse, or to artificial feeding. More evident causes must always be carefully excluded.

2. Nutritional Disturbances Caused by the Different Food Elements.—(*a*) Fat.—The fat is the chief disturbing element in feeding cow's milk. So true is this that *fat overfeeding* and *milk overfeeding* are practically synonymous. Vomiting is peculiarly characteristic of overfeeding with too much or too rich milk. Indigestion with vomiting, diarrhea, green or slimy, or curdy, cheesy bowel movements, abdominal distention, and colic due to gas, discomfort and sleeplessness, result from overfeeding with cow's milk much as they do in overfeeding with breast milk, only more readily and disastrously. A very different symptom-complex is the rule, however, in overfeeding with cow's milk. Often the first thing that attracts attention to the child is the fact that it is gaining less rapidly than it did, or is even stationary, and in a baby this is equivalent to a loss in an adult. The food is naturally increased, with perhaps a brief gain, but soon with a greater loss. It will then be recalled that during this time the baby has been more restless, has slept more brokenly, and has cried more than usual. Changes in the bowel movements, too, have occurred that are diagnostic of overfeeding with cow's milk. They have become

pale yellow instead of a rich yellow, often grayish, or even nearly white, are harder and dryer. In severe cases the bowel movements closely resemble dry putty in color and consistency and have a strong, cheesy, decomposed odor. The urine is commonly ammoniacal and irritating. The child later gets pale and flabby, is less playful and active, will not smile. The abdomen becomes soft and somewhat distended with gas. The appetite is lost. Eczemas are brought out in susceptible babies. If the condition is not relieved, or even more milk is taken, there occurs finally either an acute intoxication (see Intoxication), or else the baby settles down into a chronic state of marasmus. In exceptional cases we have seen the gain in weight uninterrupted, even excessive, in spite of gross overfeeding, characteristic bowel movements, etc. That the condition is a fat overfeeding is shown by the fact that the bowel movements are composed largely of insoluble salts of fatty acids—i. e., soaps (soap-stool)—and by the fact that the symptoms are all increased if the milk is increased, and lessened if it is lowered. This disturbance in metabolism is probably an acidosis (Czerny and Keller), due to the withdrawal of alkalies from the body to unite with the fatty acids of the intestines.

The Treatment.—The fat must be lessened and the carbohydrates increased to take its place, and the feeding interval must be a long one, preferably four hours. The fat is reduced by using less milk or by removing for a time, depending upon the severity of the condition, a part or all of the cream from the milk. The carbohydrate is increased by adding a gruel and a larger amount of sugar, preferably malt sugar, because it is tolerated in larger amounts, is more easily assimilated, is more fattening, and is more laxative than milk sugar. After some time a very gradual return to a well-balanced food is begun. This is often very difficult because of the continued intolerance for fat. If the difficulties are too great, it is often best, especially after the first half year, not to attempt to increase the fat. The carbohydrates apparently quite take the place of fat in many cases, especially in the latter part of the first year, and their tolerance is much higher. One of the best nourished babies I have seen had practically no milk fat in its food (centrifugal fat-free milk) for about fourteen out of sixteen months of its life. Such a course is adopted only if neces-

sary, because human milk contains four per cent fat, but if it is necessary, the carbohydrates, and to some extent the proteins, can take the place of the fat to an extent that is not commonly appreciated.

(*b*) Carbohydrates.—*Starch.*—When starchy food is made the important part of a young infant's food, as in the mistaken use of certain "baby foods," or in the prolonged use of cereal concoctions, crackers, potatoes, etc., quite definite conditions will result. The bowel movements are deeply colored, more brown than yellow, are loose and frequent. Diarrheas with frequent brown, watery, frothy, acid, and irritating bowel movements are common. These children are often for a time plump and firm, of good color, active, and seem healthy. The firmness of the muscles and of the tissues is, however, rather due to a hypertonic condition of the former, and to a retention of water in the latter. This accounts for the frequency of convulsions and edemas in these babies. As in milk overfeeding the final outcome is typically one of marasmus, all the more so here because acute catastrophes from which recovery is at best slow are very frequent, and add to the steady downward course. We have in these babies the minimum of immunity and of resistance, and they fall an easy prey to even slight intercurrent infections. This is probably due not so much to the excess of starch as to an inadequate amount of protein.

The Treatment.—The starch must be eliminated wholly or in part, and fat and protein given in abundance. The ideal food here is human milk, not alone because of its favorable composition—i. e., high, easily assimilable fat content—but also because it alone can supply immunizing bodies, and the highest degree of resistance to infection and other insults. If this is not feasible, then the cautious use of cow's milk whole, or diluted, with little or no cereal or sugar addition, is indicated for a time.

Sugar.—The tolerance for sugar is usually high. When given in excess the bowel movements are apt to become sour, foamy, irritating, watery, frequent and brownish like thin mustard. The addition of a cereal diluent prevents or delays this result. The chronic condition, as in starch overfeeding, is less likely to occur. Sugar in large amounts, especially cane sugar and malt sugar, if well tolerated, are very fattening, but the babies are apt to be

pale and essentially poorly nourished. We are all the more cautious now not to use an excess of sugar, because we have learned to look upon it as the fever-producing and intoxicating element in food intoxications. The frequency of these acute intoxications in babies fed on malted milk, or condensed milk with their high sugar content, is well recognized.

(*c*) Protein.—On account of the firm curd produced in cow's milk by the addition of gastric juice (rennin), and because of the regular occurrence of "curds" in the bowel movements during indigestion, the casein of cow's milk has been, and by many authorities especially in this country still is, considered the chief disturber in feeding cow's milk. This view is no longer held by any of the leading German writers. If the fat in these cases is removed from the milk, and the fat-free milk is given in similar modification, the curds, as well as the indigestion, quite regularly disappear. These curds, we are now taught to believe, are not casein but essentially fat derivatives. They never occur when really fat-free (centrifuged) milk is given and quite regularly reappear in cases with marked fat intolerance, when even a few ounces of whole milk are given in the same food. Under certain abnormal conditions, that are not sharply defined at present, large, hard masses, resembling soaked beans or dried dough, occur as well with fat-free as whole milk. These are probably essentially casein masses. These are rare, occur only when straight or slightly diluted milk is used, and when there is indigestion with increased peristalsis, and *are in no way identical with the common "curds" of indigestion.* They have seemed rather an accompaniment of indigestion than a cause of it, much as curds will appear in the bowel movements following a cathartic. It is, furthermore, quite probable that the constant motion of the stomach prevents the formation of such massive curds as we find in the stationary test tube. There is, then, very little positive evidence that the protein of cow's milk causes serious trouble in digestion. The view that an excessive amount of protein makes a dangerous demand upon a delicate and inadequate infantile metabolism is equally doubtful. In food intoxications where we have a "metabolic bankruptcy" (Finkelstein), protein alone is well borne, while fat and sugar are toxins. Nature's provision for so small an amount

of protein in human milk makes us, however, hesitate to use a larger amount unless necessary.

In the use of too little protein we have, on the other hand, a real danger. It alone contains nitrogen, and no other element can take its place. Anemia, weakness, lack of resistance are early evident in protein deficiency. If the deficiency is too great and prolonged, death results. Such lack, of course, rarely occurs in feeding cow's milk. Protein can, however, easily be given in inadequate amounts in infant foods, when a mistaken fear of " protein indigestion " leads to extreme dilution of the milk.

(*d*) SALTS.—The salts are essential in growth, digestion, and metabolism. The bearing upon nutrition of the excessive and qualitatively different amount in cow's milk is little understood. The possible connection of an excess of salts with such condition as tetany, eczema, etc., leads one to infer their possible importance. That there is great danger from an inadequate amount when, for example, an excessive carbohydrate diet with little or no milk is given, is evident. The importance of adding common salt to barley water when given alone for only a few days is easily seen.

3. **Food Intoxication** (*Alimentary Intoxication, Finkelstein*).—In the course of the acute and chronic nutritional disturbances that have just been outlined, new and startling symptoms are apt to appear commonly quite suddenly, less often more gradually. The baby that has seemed only moderately sick becomes alarmingly so. It becomes feverish, listless, drowsy, stuporous, heavy-eyed, in severe cases even comatose, and all bowel symptoms are aggravated. The child looks as if poisoned—i. e., intoxicated by a drug. This condition has been variously designated as catarrhal enteritis, gastro-enteric intoxication, entero-catarrh, summer complaint, because of its greater frequency during the summer months, and cholera infantum. To these conditions Finkelstein has given the name of *alimentary* (i. e., food) *intoxication,* because his investigations have seemed to establish very convincingly that the *food itself given in excessive amounts* is the intoxicating agent, and not a bacterial toxin as has been believed hitherto. According to this view, we have in the intoxication not the introduction of a new outside element, but simply the culmination of an unbroken series of events that lead step by step, in accordance with certain

fundamental laws, from the mildest disturbance of nutrition to the severest intoxication. While these changes lead almost imperceptibly from a less to a more severe condition it will be necessary for the sake of clearness, and also to include in the discussion the conditions commonly described separately as indigestion, dyspepsia, marasmus, etc., to divide this process into stages in which a whole symptom-complex can be designated by a name.

(*a*) The Normal Healthy Infant in its Relation to Food.—In every nutritional disorder there are certain definite departures from what we may consider attributes of the normal thriving baby. These normal conditions may be enumerated for this purpose as follows:

I. The infant makes a regular, steady gain in weight that is normal for its age, that is neither excessive nor too little. If fed more it gains more; if fed less it gains less.

II. It has a definite temperature—98° to 99° F.—a monothermia that is remarkably uniform, and any considerable deviation from which is pathological.

III. It has a wide tolerance for food, both in general and for individual food elements.

IV. It has bowel movements that are normal for the food it is taking.

V. It is contented, easily goes four hours without feeding, sleeps well, is bright and active, and smiles a good deal.

VI. It has a good color and firm tissue.

The bearing of this is evident in the following consideration of:

(*b*) The Pathogenesis of Food Disorders of Infancy.—I. *Stage of Disturbance of Balance.*—In this earliest stage that results from the administration of food beyond the infant's limit of tolerance we find irregularities chiefly in the weight and temperature. The weight fluctuates widely from day to day without apparent cause, instead of increasing steadily. The temperature likewise fluctuates abnormally, and readings above 99° F. and under 98° F. are always significant. The baby at times appears normal, and again may be uncomfortable, restless, and sleep less soundly. The bowel movements still appear normal or nearly so, and the baby is only a little paler than before. Even at this early stage

there is present a paradoxical reaction that is characteristic throughout—namely, increasing the food causes a failure to gain normally in weight, or even a loss, while lessening the food, will cause a return to normal, and even an increase in weight. This is especially true of the fat. The tolerance for sugar is still high, and that for protein is unaffected. If the condition is not relieved, and especially if, on a mistaken diagnosis that is easy to understand, still more food is given, particularly cream (i. e., fat), there is ushered in:

II. *The Stage of Dyspepsia or Indigestion.*—This corresponds to the various "gastric" and "intestinal" indigestions that always occur inseparably. The weight may increase again for a short time with the added food, but commonly becomes stationary, or shows a steady loss. The temperature is still unsteady and frequently goes considerably over normal, though this may be only for a short period of the day. The child is still more restless and fretful, cries a great deal of the time, seems hungry, and sucks its hands. The face is drawn, and even in sleep is not placid, but twitches and moves as if in pain. The baby becomes pale and flabby. The chief characteristic of this stage is the well-marked evidence of indigestion as shown in the bowel movements. There is commonly vomiting, abdominal distention and colic, an increased frequency of bowel movements, with mucus and curds, and an abnormal color and odor. They may be brownish, sour, frothy, and irritating, especially if the carbohydrates are in excess; or they may be dry, pale, hard, and offensive—i. e., the typical soap stool, or, later, frequent, cheesy, whitish or gray, slimy, and excessively foul, or greenish, curdy, strong and watery, if the fat is the chief disturbing element. Various combinations occur, and it is not always easy or possible to pick out the exact cause. The condition may become subacute or chronic. The tolerance for fat is so reduced that frequently only a small amount is consistent with return to normal. The carbohydrates are better tolerated, as a rule, but much less so than before. The peculiar form of indigestion would, of course, to some extent influence the relative tolerance for these two elements. The protein alone is still apparently tolerated perfectly. Two conditions may now arise that are successive stages of severity in one way, and yet are

in many ways antithetical—that is, a stage of marasmus, or one of intoxication.

III. *Stage of Decomposition.*—As the term implies, in its German meaning, we have here an actual beginning of disintegration of tissue. The typical clinical counterpart to this condition is marasmus, atrophy, or athrepsia. These babies may remain stationary in weight for weeks and months, or may even lose steadily; we have, finally, the hungry, emaciated, pale, fretful, weakly baby, with its shriveled, wrinkled, old-looking face, bony body, and large, distended abdomen. With this low vitality there is a strong tendency to subnormal temperatures that rarely reach 98° or even 97° F., and often sink to 95° or even 93° or 92° F. The bowel movements often appear nearly normal, but are commonly formed and constipated, especially in the chronic cases of milk overfeeding that are peculiarly typical of this stage. In other cases they may be continually dyspeptic, or alternating with periods of constipation. Tolerance for cow's milk fat is here reduced to a minimum, and in severe cases life can hardly be maintained with its continued administration. The tolerance for carbohydrates is likewise greatly reduced, but less so than for fat, that for starch remaining higher than for sugar. The protein is still well borne, except, perhaps, in the severest cases. Such cases are wholly unnourishable, and death is inevitable. In any of the severer cases a single dietetic error may reduce the child beyond recall. In the preceding stages human milk acts as a specific, and can be given freely. Here for the first time tolerance for human milk is lowered, and in extreme cases even absent. While it still forms the specific food, it must be given with extreme caution, or there will be either a severe paradoxical reaction or else an intoxication. The stage of decomposition may last for months and result in extreme marasmus, or only for a very short time. A dietetic error, increasing the fat or sugar too rapidly, will readily bring on an intoxication. Mixed conditions in which the stage of decomposition is at one time predominant, and at another time that of intoxication, are frequent.

IV. *The Stage of Intoxication.*—The prodromal stages of a food intoxication may be well marked into stages of considerable length, as indicated above. Again, they may follow one another so rapidly that the child is first seen in the midst of a well-devel-

oped intoxication, and only upon careful inquiry will the history of a previous disorder be elicited. It is evident that any number of combinations can precede the actual culminating intoxication, and that this itself may be gradual or come on like an explosion in uremia. Commonly, to a previous digestive or other disorder that has not seemed at all alarming, there is suddenly added the evidence of an intoxication brought on by an increase of food, especially the fat or the sugar, to a point beyond the limit of tolerance. The child now looks sick; its eyes are heavy, half closed, often fixed and unmoving. It looks drowsy, stuporous, "dopey," is hard to rouse, and may even become comatose. If at all severe, the baby seems in collapse. We have here for the first time a continuous fever, the temperature rising to 101° to 105° F. or more, depending upon the previous condition of the infant and the degree of dietetic abuse. The respiration is peculiarly altered. The breathing is rapid, deep, and pauseless. This may be barely discernible, or the child may literally pant for breath. The loss in weight is rapid and continuous, many times as great as that of starvation alone. Diarrhea, with dyspeptic stools, is the rule. This reaches its maximum degree in cholera infantum, where the bowel movements are simply spurts of foul turbid water, that is forcibly ejected every few minutes. In certain cases the severity of the intoxication seems to paralyze the intestinal movements, and even cathartics and enemas are unavailing for a time. The liver is often enlarged, in certain severe cases advancing steadily till it reaches the umbilicus (Walls), and causes the upper part of the abdomen to protrude. There is present a moderate leucocytosis, 20,000 to 50,000; there is sugar (lactose and galactose) and albumin and casts in the urine. The appetite is usually lost completely; in milder cases the baby drinks water eagerly, in the severest cases it will not even swallow it if put in its mouth.

The paradoxical reaction is here most convincing. The tolerance for food is zero. To continue the food that has caused it is dangerous in the extreme. The child is in a state of "*metabolic bankruptcy*" (Finkelstein), and even the smallest amount of fat or sugar acts as a toxin or poison, as can easily be demonstrated in any case. The sugar is probably the real intoxicating agent, while the fat is the important factor in the prodromal stages. The

tolerance for protein, both casein and albumin, still remains unchanged. Even human milk, with its abundance of fat and sugar, is no longer tolerated, as we might expect.

These intoxications occur not only as the final picture of a series of metabolic disturbances caused by overfeeding, but likewise arise in the course of any general infection, such as typhoid, or pneumonia, or ileo-colitis, or of any general disturbance such as nephritis, that affects the whole organism to such a degree that the administration of a sufficient amount of food, especially one rich in fat and sugar, will call out an intoxication. The clinical picture of the intoxication is the same in all conditions. The possible bearing of this upon the toxemias of typhoid and other infections is evident. In typhoid in young children we have repeatedly seen the toxic symptoms disappear as rapidly as in the simple food intoxications, when the fat and sugar were withdrawn from the food. The exact nature of the toxins is not known.

These food intoxications occur most frequently during the hot months of July and August, as we might expect. The child's general condition is lowered by the depressing heat, and its ability to handle food correspondingly lessened. Commonly the baby gets the same amount of food whether the weather is hot or cold. It naturally requires much less food to maintain its animal heat in an atmosphere of 85° or 90° F. than in one much cooler. Consequently it is relatively overfed by getting the same amount of food. Diarrhea has been produced in guinea pigs by simulating this condition by heating the room in which they were kept (Maurel). It is certainly hard to explain, on a bacterial basis that is so commonly accepted, why these conditions should arise when sterile food is given and why they should occur more frequently in summer, even though the food is sterile, or even human milk. In cases carefully fed and kept cool there is little more danger of intoxications during the summer than during the winter. The food should be materially lessened during hot weather.

(*c*) Treatment of Food Disorders.—*Prophylaxis.*—In feeding healthy babies our constant aim is to keep them free from these disturbances. It is for this reason that long intervals between feedings and caloric and volumetric control are so urgently recommended. Improperly balanced food mixtures, such as many of the

"baby foods," should be avoided. The appearance of any stage of a food disorder should be recognized at the earliest possible moment and a more serious condition avoided by proper dietetic measures.

Curative.—In the earliest stage it is simply necessary to cut down the amount of food to a proper one, or for a time below that amount. If either fat or carbohydrate is excessive, it should be reduced and a more properly balanced mixture given. Caloric control is here of value as a measure of the maximum amount of food to be permitted.

In the dyspeptic stage it is commonly well, except in the mildest cases, to give a starvation diet of water, or tea, or barley water, for twenty-four hours. The return to a proper amount of an appropriately modified milk mixture must be gradual and under the necessary clinical control. In severe cases it is best, after a day of hunger diet, to begin with a skimmed, or even fat-free, milk and cereal-water mixture; then add sugar, and finally add whole milk or gradually leave in more and more cream. Human milk is here, as in the preceding condition, the specific remedy.

In the stage of decomposition human milk is often indispensable and always the ideal food. It must be used, however, with caution, at first, in severe cases, because it may lead to a severe paradoxical reaction or to an intoxication. We have repeatedly seen one or the other alarming result when a weak marantic baby, with low vitality and subnormal temperature, was suddenly put freely to a generous breast. In the worst cases only two or three ounces a day can be safely tolerated at first, and for this the milk is best drawn by hand or pump. These cases die without human milk. To meet this important indication, Dr. Walls introduced the employment of one or more wet-nurses at our ambulatory clinic at Northwestern University Medical School, and we are able to save many of these cases that would otherwise be hopeless. The amount is gradually increased to what is necessary, or cow's milk is gradually substituted. In less severe cases the human milk can be given freely. The breast milk acts in these cases apparently not only as a food, but has, furthermore, some specific curative property, and only a few ounces a day in the twenty-four-hour food mixture seems to be of decided benefit. One wet-nurse can thus

be of extensive usefulness even in an out clinic. If human milk is not obtainable, we enter upon the unequal struggle with milk mixtures from which the fat has been wholly or partly removed with the addition, at first, of only a small amount of sugar, preferably malt sugar, and the addition in older infants of cereal waters, or dextrinized or baked flours, broths, etc., and slowly progress to a better-balanced food. In the latter part of the first year children of this type will often do better when additional food that is appropriate for a baby of that age is given than if kept too rigidly on a milk mixture. These cases must not be started off with a day of starvation unless there is a complicating intoxication, because this additional insult may diminish the vitality of the disintegrating child to the extinguishing point. With the slightest dietetic error, and often apparently without evident cause, these babies will gradually sink into an alarming state of low vitality from which it is only too often utterly impossible to rescue them.

Treatment of Intoxication.—We have here to deal with an intoxication by food, and the first step is to withdraw all food for at least twenty-four hours, no matter what the condition of the baby. The customary cathartic can usually well be dispensed with, except in those severe cases where obstinate constipation exists at first. The bowels are rapidly emptying themselves as it is, and there is reason to believe that calomel and castor oil are not entirely harmless. The former is distinctly irritating, and several clinical observations have led us to believe that the use of a teaspoonful or two of castor oil, a fat equivalent to that of three to six ounces of milk, may seriously aggravate conditions. Colonic flushes, too, would seem of little use. The absence of intestinal lesions and the prompt effect of the withdrawal of food alone leave little use for drugs. In place of food, then, we give water, or a weak infusion of tea, or, if desirable for the mother's sake, a weak cereal water, or albumin water. Sugar, of course, must not be added to these. If water is not taken freely without sweetening, as is very frequently the case, then a grain of saccharin is best added to the quart of fluid. *The child must have water at any cost.* It can commonly live many days without food, but very few without water. If too sick to take it from a bottle,

it must be given from a spoon, or by rectum, or, better still, the stomach may be washed out with a catheter and funnel, and a large amount left at one time, and repeated *p. r. n.* If vomiting and diarrhea are prominent symptoms, normal salt solution may be given under the skin in repeated small amounts. This is especially true of cholera infantum where these conditions are present, and where the loss of water from the bowels is the alarming symptom. It is in these conditions, where an insufficient amount of water is retained, that scleremic conditions and marked apathy occur. If the pulse is very weak, and especially if it becomes slow and only one sound of the heart is heard at the apex, hypodermic stimulation with camphorated oil, digitalis, adrenalin, etc., is indicated.

The change from an alarming condition to one of undoubted convalescence within twelve to twenty-four hours reminds one strikingly of such changes as the crisis in pneumonia or the result of opening an abscess, and is one of the quickest and most decisive therapeutic results in medicine. A child with heavy, fixed eyes, and in stupor, with a temperature of 105° F., is often on the following day found to have a normal temperature, with eyes bright and with no trace of intoxication. If this disintoxication has taken place at the end of twenty-four hours, we can proceed with the feeding. If not, and the child is only partly convalescent, we can safely wait another day or even two, if the child was previously fat and strong. One must never wait for the usual yellow bowel movements before proceeding. *The normal water-diet bowel movement is soft, semi-transparent, or slimy, and of a dark greenish-brown color,* and continues in spite of the withdrawal of food.

From what has been said before, we would expect to be able to give the different food elements in the following order: Proteid and gruels, starches in older babies, sugar, and, lastly, fat. If we could easily separate the casein and obtain it in a serviceable form we would not hesitate to use it in considerable amount from the start. We have several times given the pure washed casein of twelve to sixteen ounces of milk to the severest cases of intoxication with only the happiest and most unexpected results in view of the still prevalent teaching of difficult proteid digestion. Practically the

simplest procedure is to begin on the first day of convalescence with a small amount of boiled fat-free milk, say ten to sixteen ounces of separated milk, less if skimmed or siphoned, with an equal amount of barley water with saccharin, if necessary. This is gradually increased till the baby gets perhaps two ounces of fat-free milk to the pound of body weight. Sugar is then cautiously added, or, in older children, starches and partially dextrinized flours, till an ounce to an ounce and a half is given in the daily food. After this is well tolerated, whole milk is gradually substituted for the fat-free milk, and an appropriate diet for a healthy infant of that age and weight is approached as rapidly as its condition will permit. The greatest danger is from too rapid giving of fat and sugar. At the beginning, the sugar of the fat-free milk even may be injurious and may necessitate slower progress. The signal that fat and sugar tolerance have been reached is the reappearance of fever and the other symptoms of intoxication. Such a relapse is simply another intoxication, and requires a repetition of the treatment given in the original one. The necessity for taking the temperature and otherwise watching the child is evident. Only when we know the infant's *immediately present condition* do we know what to give next. The same food that today may be ideal, may to-morrow, under altered conditions, act as a toxin.

When the stage of intoxication is reached, the tolerance for human milk, too, is lost. The child must be taken from the breast at least twenty-four, often forty-eight, hours, or even longer. The breasts must be emptied as thoroughly as possible several times daily, to keep up the secretion, by hand or by breast pump, but much more effectively by another baby. Nursing is cautiously resumed after disintoxication has taken place, with long intervals and very short nursings. In the severest cases, even after several days of starvation, the milk, with its large fat and sugar content, will again bring on an intoxication. We have here repeatedly seen the startling phenomenon that an infant will tolerate, perfectly, separated fat-free cow's milk in considerable quantities, while human milk is toxic in minimum amounts. The significance of this fact in the pathogenesis of this food disorder cannot escape one.

C. SCORBUTUS—INFANTILE SCURVY—BARLOW'S DISEASE

This is apparently a purely dietetic disorder occurring during the first two years of life, and most frequently during the middle and latter part of the first year. The etiology is not as yet wholly clear, but the following factors seem most important:

(1) A dead food, such as condensed milk, malted milk, boiled or pasteurized milk given for a long time.

(2) A predisposition on the part of the child that may be inherited.

(3) A food lacking in proper proportions of food elements, perhaps too little protein.

Environment plays no part. The essential lesions are in the blood and blood-vessels, causing hemorrhages under the periosteum, especially near the ends of the long bones, tibia, femur, etc., from the gums, and more rarely from the bladder, in the orbit of the eye, and in other places. We have, then, extremely painful swellings over the bones and purple and spongy, bleeding gums about the teeth. Often the only evident symptom is tenderness about the knee or ankle, so that the child screams when it is moved, and even when approached. This alone is usually diagnostic in an infant.

Treatment.—The treatment is purely dietetic and most gratifying. Raw milk is substituted for its former food, or, if necessary, pasteurized or very slightly boiled milk, and orange or other fruit juices given freely from one to four ounces a day. Human milk is highly antiscorbutic, and so always acts favorably. If the child has developed it on the breast alone, that breast is no longer to be used without other food.

D. RACHITIS (RICKETS)

This is a fundamental nutritional disturbance, occurring most frequently between the sixth and eighth months, and is due to a combination mainly of improper food, poor hygienic surroundings, race, and climate. The Italian and the negro are peculiarly susceptible in the north temperate climate. Practically all colored

babies in the North become rachitic, even on a good breast, while in the South the condition is rare. The rachitic baby is pale, flabby, pot-bellied, large-headed, though commonly fat. The other striking symptoms are in the bones. These fail to harden properly, or even become softer, are thickened at the four corners of the head, and at the epiphyses of the long bones, especially at the wrists, ankles, and sternal ends of the ribs. Various deformities of the chest and limbs occur as a result of these changes. Teeth appear late, from the tenth to the fifteenth month, or later. The muscles are weak, and walking occurs late.

Rickets rarely occurs to any degree in white children on good breast feeding. It is rarely absent in severe degree in babies fed for a long time exclusively on any proprietary food that is used without fresh milk. The small amount of fat and fresh animal proteid, and the large amount of carbohydrates, are doubtless important factors. Fat overfeeding will quite as definitely produce it. Slight evidence of rickets occurs in nearly all babies that are fed artificially, and in many on good breast feeding. Striking symptoms occur only in serious errors in diet and hygiene, except apparently in certain conditions of race and climate. Its essential nature is not clear. Marantic babies are commonly not rachitic.

Treatment.—Fresh milk, appropriately modified and in proper amount, together with such other food as is indicated for that age and weight, is the important point. Fresh air, day and night, sunshine and outdoor life are only next in importance. Cod-liver oil, especially with the addition of phosphorus, is a very valuable addition to the treatment.

E. DYSENTERY OR ILEO-COLITIS

As the name implies, we have here an inflammatory condition, often with extensive ulceration of the colon, and of the distal portion of the small intestine.

The *Shiga* bacillus is the most common or even the specific cause. The characteristic symptom is a diarrhea with ten to thirty bowel movements a day, that are composed largely of mucus and

blood, often with considerable pus, have a peculiar mawkish odor, and are so irritating that their passage is accompanied by extreme tenesmus and eversion of the rectum. There is a high, continuous temperature, 102° to 105° F. for a week or longer, that is uninfluenced by withdrawal of food. There is often complete anorexia, great restlessness or apathy, prostration, etc., but not the rapid breathing and nervous depression of an intoxication, unless this is a complicating factor. The clear eyes of the one (even though the temperature may be 105° F.) make a striking contrast with the heavy, half-closed, languid eyes and stuporous state of even a mild intoxication, when they are seen side by side.

Treatment.—The intestinal tract is emptied of its food contents by a twenty-four-hour water, or tea, or barley-water diet. The temperature, frequency of bowel movements, etc., are but little influenced by this as compared with those of an intoxication. Our aim is now to give water freely, and to give a food that will be as little irritating as possible to the inflamed mucous membrane, will be nourishing, and yet will not superinduce an intoxication upon so favorable a foundation. The food that naturally commends itself, from all that has been said, is a boiled fat-free milk and a cereal-water diluent, and this can be given after the first day of starvation and continued throughout. There is an essential difference in composition and in its effect on the baby of separated (centrifugal) fat-free milk and skimmed milk. The latter contains a considerable amount of fat that can act as an irritant and favor the production of an intoxication. If separated milk cannot be obtained, one must proceed more cautiously with skimmed, or preferably siphoned milk. One must never wait in these cases for even approximately normal bowel movements, nor for the characteristic hunger-diet bowel movement before beginning to feed them. Albumen water and in older babies broths are useful additions, but contain little nourishment. Only after the temperature and bowels are normal or nearly so, is it wise to add more starches and dextrinized flours; in older babies, sugar, and lastly and cautiously whole milk. In strong, vigorous, fat babies one can often be content if they take water alone, freely for days, if they refuse food. In others it is commonly best to resort to

gavage, especially if the water taken is likewise deficient. Often only a few such feedings have a marked effect. Rectal feeding is not feasible.

Drugs that check excessive peristalsis and pain, that soothe inflamed mucous membranes, and possibly intestinal antiseptics, are all useful. Flushing the colon with cleansing non-irritating fluids, such as normal salt solution, or with mild antiseptic solutions, would seem peculiarly indicated because the lesions are largely accessible. Their effect in relieving, if only temporarily, the distressing tenesmus is not the least benefit derived from their use.

F. INFANT FEEDING DURING ACUTE ILLNESS

During acute illness in infancy from any cause, and especially in fevers, there is a temporary partial or complete cessation of the function of digestion and assimilation, and the food should be materially lessened. Nature commonly meets this indication most vigorously by establishing anorexia, vomiting, and diarrhea that limit the taking and the assimilation of food. Intoxication is especially to be avoided along the lines indicated under that heading. Sugar, and especially fat, are to be used with caution. Fat-free milk, albumen water, farinaceous drinks, and in older children broths and fruit juices, may be given freely. On account of the high tolerance for human milk and because of its specific properties, breast feeding is safely continued. Except in weak babies that can nurse only a small amount, the interval between nursings should be long, at least three, better four, hours, and it is often wise to limit the time of nursing.

CHAPTER XIV

PRINCIPLES OF SICK-ROOM DIETETICS

A. CHOICE OF FOODS FOR SICK PEOPLE

THE importance of a wise choice of food for invalids can hardly be overestimated. The problem of a proper choice is not by any means a simple one. Certain fundamental principles should govern this choice. In the first place, one should choose quite a different diet in an acute disease from that which would be appropriate in a chronic disease.

1. **Acute Conditions: Non-febrile.**—Simplest of all these cases for the dietitian is the care of the surgical case and the childbed case. As a rule, the patient has a good appetite and good digestion. The patient has been active and in a good state of health up to the time of confinement to the sick room. The only precaution to be observed and the only rule to be followed is to decrease the quantity of food taken to bring it within rational needs of the patient. If a robust laboring man is confined for weeks or even months because of a broken leg, the physician and nurse may have difficulty in convincing him that he should not eat as freely after his confinement as he did when employed at his usual work. If, however, his appetite is not curbed, he is certain within a few weeks to suffer from a seriously deranged nutrition. While he may have a general diet without any special restriction as to kinds of food, the quantity of food should be reduced to not more than half of his usual ration. No small ingenuity will be required on the part of the nurse and on the part of the attendants to convince the patient that he is getting enough. He will feel empty and hungry a good deal of the time, unless tact and good judgment are used.

Two devices may be employed which will go a long way toward satisfying the patient: First, introduce into his dietary during the first two weeks, particularly, a considerable amount of bulky food that possesses only a small amount of nourishment. An ample bowl of thin soup, hot and well seasoned, will fill an aching void and make the patient feel comfortable. Fruits prepared as sauces, stewed with a considerable admixture of water, serve a similar purpose, and the free use of various drinks, bouillons, beef teas, etc., will give the patient a feeling of comfortable satiety but will really introduce into his system a small amount of nourishment, and, furthermore, the introduction of a large amount of liquid will also facilitate freer bowel movements and freer and easier secretion from the kidneys.

The second device of great importance in these cases is for the nurse to urge upon the patient the great importance of spending as much time as possible at his meal; let him be encouraged to spend a whole hour on a small meal, sipping his soup very slowly and deliberately, and chewing all solid foods as long as it is possible to retain them in the mouth. If this can be satisfactorily accomplished, both patient and attendants will soon be surprised at the small amount of food which will cause complete satisfaction of the appetite and give a feeling of comfortable satiety.

In the case of the woman in childbed, her condition is also an acute one. The physician and nurse will remember that while she is to be confined to her bed without exercise for a period of two or three weeks, the function of lactation must be established, and once established, the nourishment for the baby must be provided. The mother should, therefore, not be put upon a particularly scanty diet; in fact, her diet may be quite as full a one as she had before her confinement, but especial care should be taken that considerable liquid and a sufficient amount of laxative food be used to insure free and regular passages of the bowels.

In the case of surgical operations for tumors and the like, if the patient has been in a fairly robust condition of general health, the same principles should be followed as govern the choice of foods in the case of a man with a fractured femur. If, however, the operation is for the purpose of making a gastro-enterostomy, or other operation on any part of the alimentary tract, it will be

a matter of great importance to fit the diet especially to the needs and exigencies of the case. In such cases the nutrition is usually seriously interfered with because of previous weeks or months of progressive development of the condition. Complete fasting for three or four days is not to be favorably considered, and yet nutriment must be introduced into the system. Rectal feeding has to be resorted to in such cases; the technic of this manner of feeding will be described later.

2. Acute Febrile Conditions.—The onset of infectious diseases, as pneumonia, is almost invariably associated with a complete loss of appetite on the part of the patient. Sometimes this may be ushered in with actual nausea; all such initial symptoms in acute febrile conditions must be interpreted as Nature's remonstrance against the taking of food. Any food forced down against this remonstrance, if retained at all in the stomach, will be only imperfectly digested, and as a result of the imperfect digestion, large quantities of toxic substances, products of bacterial action or of the overaction of the digestive ferments upon the slowly absorbed food, will accumulate in the intestine. These toxic substances absorbed into the blood only aggravate the condition of the patient. As a rule, the patient craves water and does not crave any form of food, even beef tea and broths. The rational dietetic procedure in all such cases is to withhold all foods for from twenty-four to seventy-two hours, according to the conditions. Satisfy the patient's craving for water by giving him all he will drink. While there is really nothing in the world better adapted to the case than pure, cold water, and in many cases nothing more craved by the patient than this drink, still, there is no contraindication to the introduction of variety into the drinks, by giving lemonade, orangeade, grape juice, Vichy or Apollinaris, or any one of a score of drinks, principally water. Even tea or coffee, hot or iced, may be used if craved by the patient. If the tea or coffee is given in a comparatively strong decoction, their stimulating effect upon the heart must be taken into consideration. The physician must decide whether or not he wishes heart stimulation. After the initial period of fasting in these cases the food should be very carefully chosen and especially adapted to the particular case. It should always be small in quantity and easily digested.

Regarding special dietaries for special conditions, more will be said in the next chapter.

3. **Chronic Diseases.**—Among the chronic diseases may be mentioned valvular disease of the heart; interstitial nephritis, degenerative diseases of the liver; degenerative diseases of the nervous system, as locomotor ataxia. These chronic diseases incapacitate the patient more or less completely from his general activities. They are very likely to occur in people past middle age. The development of the condition is a very gradual one, the disturbance of nutrition may be more or less profound, the diet must be adapted to the special conditions. If the digestion remains fair, as it is likely to in heart disease, nephritis, diseases of the nervous system, the patient is very apt to be cared for in the home and is not likely to have the personal attention of a trained nurse. In such cases the physician gives his directions regarding diet to the members of the family who attend the patient. About the only directions that can be given of importance in such cases is that the diet be light, easily digestible, laxative, and low protein. The free use of fruits, of eggs and milk, of gruels, purées, cream soups, and of custards, should satisfy all these requirements and may easily be grouped into attractive menus.

B. THE SERVING OF FOOD TO THE SICK

In feeding the sick, whether in the home or in the hospital, we are very likely to be governed by the three-meal-a-day tradition, and by the sentiments of interested friends rather than by sound judgment. The physician and attendants of the sick are frequently embarrassed, and not rarely actually diverted from a rational plan by these traditions and sentiments. In the home the well members of the family feel that if the sick one does not have three square meals a day he is being neglected and starved. In the hospital visiting friends are likely to feel that if an amply loaded tray is not brought into the room during the visit the patient is not getting the worth of his money.

As indicated above, sound reason frequently dictates a complete

cessation of all food ingestion for twenty-four to seventy-two hours in the early stages of various diseases. The appetite of the patient may be usually taken as a safe guide, if not as to the particular kind of food the patient should have, surely as to whether or not he should have any food at all. After the initial fast the food must be selected with respect to the needs of the patient and to his cravings. To be properly and quickly digested the food must excite appetite. Here are a few principles that may govern the attendants of the sick:

I. *Never serve more food than the patient is supposed to take.* A precarious appetite that would relish a small amount of well-cooked food daintily served often experiences a complete revulsion when a great quantity of food is presented; so in the rick-room we may well depart from that code of etiquette that prompted our ancestors to lead their guests to a table groaning under the weight of food enough for three banquets.

II. *The tray, the linen, and the dishes should be absolutely spotless in their cleanness.* The dishes should be pretty and dainty, the linen the best that the house affords. The silver should be polished; food should be put upon the beautiful china dishes in an artistic way, garnished, if possible, and never smeared about the edges of the dishes, or dripped upon the napkins which cover the tray. As the tray is taken to the sick-room from the kitchen, it should be covered by a napkin. When this is removed in the presence of the patient the meal should always present at least one surprise to tempt the appetite.

It goes without saying that flies should be kept out of the sick-room and out of the kitchen absolutely for various reasons: first of all, on general sanitary grounds, to prevent the spread of any communicable disease to other members of the family or the neighborhood. Second, on æsthetic grounds, to promote the comfort of the patient. If flies alight upon the tray containing the food just brought from the kitchen, just this fact—trivial though it may seem to a healthy person with a strong appetite—may completely destroy all craving for food, and the patient turns away from his meal in disgust.

III. Cater to the patient's idiosyncrasies and personal likes and dislikes in the preparation of his menu, but do not consult him

about it in advance. Members of the family may be consulted, but let each meal have at least one surprise in store.

IV. Physical preparation of the patient must be cared for if the meal is to be enjoyed. First of all, let the patient be put in a comfortable position, if that is possible. Second, let the face be washed with a wet wash cloth or sponge and dried. Let the mouth be thoroughly rinsed with cold water. After this preparation the patient waits expectant for his meal while the nurse goes to the kitchen to bring it. Not to be ignored in importance is the personal cleanliness of the nurse herself. Particularly must the hands have been evidently recently washed in preparation for the occasion whenever it is necessary for her to assist the patient in eating, or to feed the patient. If all of these little precautions are adopted, and all of these principles faithfully observed, the result will usually be satisfactory.

C. RECTAL FEEDING

Not infrequently the physician and nurse are confronted with a condition where the feeding by way of the mouth is impossible for a period of a few days, or even in rare cases perhaps weeks. If such a condition happen as a sort of sudden emergency, and the patient is in a well-nourished condition, a fast of seventy-two hours or even more could be well borne. However, as a rule, the condition is found as a culmination of changes that have been going on for many weeks or months, and is usually associated with a considerable disturbance of nutrition and loss of weight. A protracted fast would seriously complicate the case. Nutriment must be given; there must be no interruption in the income of materials for repair and for fuel. This necessitates rectal feeding. When this method of introducing nourishment into the body is followed with the proper technic, it may suffice for maintenance of the body for many days. A few general directions must be observed:

I. The rectum should be prepared for the feeding by a more or less copious injection, whose purpose is to empty and rinse out the descending colon and rectum. At the end of this rectal

lavage two or three ounces of normal saline solution (0.6 per cent common salt dissolved in water) may be injected high up in the rectum and left there to be absorbed.

II. For rectal feeding use high injection only, which can be accomplished best through the use of a large catheter or a stomach tube. Normal saline solution and nutrient enemata should always be carried eight or ten inches into the rectum in order to facilitate its retention and its readier absorption.

III. The patient should lie upon his side with the hips elevated when that is possible. When the patient cannot lie upon his side the foot of the bed may be elevated.

IV. The catheter should be oiled with vaselin and should be introduced with great care in order not to irritate the mucous membrane by catching the point of the catheter in its folds. If the catheter is advanced slowly and twisted as it is advanced this can usually be accomplished without irritation.

V. The quantity of the enema should never exceed three ounces for an adult, and would better, as a rule, be one and a half or two ounces. In children it should be proportionately smaller.

VI. As to interval of time, nutrient enemata should not be given more frequently than once in four or five hours. Between the nutrient enemata thirst-slaking enemata may be given in the form of normal saline solution (0.6 per cent sodium chlorid).

VII. As to foods adapted for use in rectal enemata: Among the proteins, white of egg and expressed beef juice are the best adapted of the native proteins. When thus given they should always be salted, as the presence of salt seems to facilitate absorption. The white of egg is, of course, diluted with several volumes of water; the beef juice may be diluted with an equal volume of water. While these proteins will be in part absorbed through the wall of the rectum, absorption of proteins is much facilitated if they are peptonized.

In peptonizing proteins for rectal feeding the pancreatic ferment trypsin should be used, because peptonization with trypsin takes place in alkaline medium, while peptonization with pepsin takes place in acid medium only. A mixture of peptone and proteoses in solution may be given. However, the peptonizing process may take place within the rectum if hashed pancreas or pancreatic

extract is mixed with the food. Preparations of "pancreatin" represent the pancreatic ferment and are easily obtainable, and may be mixed with the food in its preparation. The peptonizing process, beginning in the warm food material outside of the body, will continue as absorption progresses until the whole mass is peptonized.

Milk is much used in rectal enemata, but should always be peptonized through the use of pancreatin before injection, as the casein is not readily absorbed. Even hashed beef may be mixed with pancreatin and reduced to a pasty mass diluted with several volumes of normal saline solution and serve as one source of protein food.

Unchanged fats, as olive oil, cream, and butter, seem not to be absorbed from the rectal mucous membrane. It is, therefore, useless to introduce fats in any form as they not only fail to be absorbed, but may interfere with the absorption of other foods. Even the yolk of egg contains too much oil to make it a favorable rectal food. Applying the general principle of predigestion of rectal food, we would expect fat to be largely absorbed if introduced in the form of a very dilute soap solution. Inasmuch, however, as the carbonaceous foods are amply provided for in the absorption of sugars and starches, there would seem to be no special advantage in the use of fats.

Sugar is readily absorbed from the rectum, but its solution should be quite dilute, never exceeding three or four per cent in strength. When peptonized milk is used, the milk sugar represents just about that strength, and no more sugar need be added. When beef juice or white of egg is used sugar may be added up to the proportion suggested. If sugar or salt is present in the rectum to a greater degree of concentration, it is likely to act as an irritant to the rather sensitive mucous membrane and lead to an expulsion of the contents. While thoroughly boiled and diluted starch is in part absorbed from the rectum, the proportion absorbed will be very greatly increased if a diastasic ferment is added, as this will digest the starch, reducing it to maltose.

Some of the nutrient enemata that have been devised contain wine, but inasmuch as wine interferes somewhat with the absorption of foods present, its admixture with an enema is not advisable.

If the physician wishes to administer alcohol, that would best be done in a separate enema when the rectum is free from food; it should be diluted with normal saline solution and should not exceed four or five per cent in strength. Not over three ounces should be given at one enema. About the proper strength would be attained by adding one teaspoonful of grain alcohol to three ounces of normal saline solution.

It sometimes happens that the patient has a good deal of difficulty in retaining the contents of the rectum. Observe the following precautions: Introduce the enema very slowly, having it at body temperature; introduce it through a narrow catheter put high in the rectum, the patient lying upon his side. Firm pressure should be exerted over the anus with a towel for some minutes after the introduction of the enema. If, after observing all of these precautions, the patient is unable to hold the contents in the rectum, then it may be made less irritable by adding five to ten drops of laudanum to the enema. As the use of an opiate for this purpose interferes slightly with the absorption of the food and exerts its regular systemic effect, it is better never to use it unless absolutely necessary.

D. ALCOHOL IN THE SICK-ROOM

The old claim that alcohol is a food makes it necessary to make some statement here regarding its use in the rick-room, notwithstanding the fact that it has recently been shown to have no food value. While the effect of alcohol upon the healthy individual is always deleterious when it has any noticeable effect, still, it is believed by many clinicians that it has a distinctly advantageous effect on certain febrile conditions. That it has an actual food value is, of course, out of the question, but it may decrease body waste in fever by decreasing metabolism. Its narcotic drug effect, sufficiently explained above, would easily make such an effect possible, and it is altogether likely that herein lies any advantageous effect that alcohol may have in these cases.

Whether the physician administers alcohol to his patient will depend largely upon the previous habits of the patient. If he

has been used to moderate amounts of alcohol the physician may consider it wise to continue its administration. However, even in these cases the responsibility should always be assumed by the medical attendant, and never by the nurse or other attendants. In carrying out the physician's directions the dietitian will need a certain amount of information regarding various alcoholic beverages.

Alcoholic Beverages may be classified into two general classes, Distilled and Fermented.

Distilled alcoholic beverages comprise spirits and liquors. The spirits are represented especially by whisky and brandy, whisky being distilled from fermented grain, as wheat, corn, or rye, and containing from 50 to 58 per cent of alcohol, while brandy is distilled from fermented fruit and contains from 42 to 55 per cent of alcohol. Liquors are prepared from distilled spirits by adding various flavoring matters. Distilled spirits should never be given full strength but should be diluted with at least three volumes of water or other liquid. This proportion should be particularly observed if they are to be taken upon an empty stomach, as the full strength of spirits would have a strongly irritant action upon the mucous membrane of that organ.

Fermented alcoholic beverages include ales, porters, beers, and wines. Ales, porters, and beers contain from 3 to 10 per cent of alcohol, and wine 6 to 22 per cent. In a general way, it may be said that the less alcohol beer contains the better it is and the least disturbing to the body functions.

Wines are subdivided into four classes: spirituous, astringent, acid, and sparkling. *Spirituous wine* is that to which spirit has been added in the form of grain alcohol or brandy. These may be subdivided into two varieties, the spirituous dry wine, the examples of which would be Port and Sherry, and the spirituous sweet wine, containing 17 to 22 per cent alcohol and a larger amount of sugar than is found in the dry wine; examples of these would be Malaga and Tokay.

Astringent wines, usually red in color, contain only the alcohol incident to the fermentation of the sugar of the grape, and this does not exceed 15 per cent, more usually 10 to 12 per cent. Their astringency is due to the presence of tannin, which is extracted

from the seed, skins, and stems of the grapes incident to the fermenting process. Examples of astringent red wines are Claret, Bordeaux, and Burgundy.

Acid wines contain about the same percentage of alcohol and are usually white in color, as they are prepared from white grapes. The acidity is due to the presence of acetic acid and tartaric acid made more evident to the taste through the depletion of the sugar in the fermenting process. Examples of white acid wine are Rhine and Moselle.

The sparkling wines are those in which carbon dioxid gas is held under pressure. Among these wines are the champagnes. The natural champagnes are those in which the carbon-dioxid gas collects as a result of the fermenting process. The carbon-dioxid gas is retained by bottling the wine while it is still in the process of active fermentation. The CO_2, unable to escape, gradually collects until the pressure is high and until the fermentation process gradually ceases. On removal of the cork from a champagne bottle this carbon dioxid escapes rapidly at first, more slowly later, until an equilibrium has been restored between the CO_2 of the wine and that of the atmosphere. The best natural champagnes require several years in the making. This has led to the preparation of artificial champagnes in which the carbon-dioxid gas is forced in at the time of the bottling. These champagnes may be very quickly prepared. While they differ somewhat in flavor, they are not essentially different in physiological action on the system. Champagnes have been classified as sweet and dry, the sweet champagne having a larger proportion of sugar, the dry champagne a larger proportion of alcohol.

Because of the presence of acid and also a certain amount of tannin in all of these wines, they all hinder digestion, not only the gastric digestion but also the intestinal digestion. Naturally the astringent and acid wines are more deleterious than the others. The sparkling wines are less deleterious than any of the other varieties in their influence upon digestion.

Aside from the interference with the digestive processes by the tannin and acid present in the wines, the principal action of these on the system is due to the presence of alcohol.

In its drug action alcohol, as stated above, under "Food Ac-

cessories,'' decreases muscular power, decreases the force of the heart action, and acts as a narcotic on the central nervous system. Whenever the physician wishes to produce these effects he has in alcohol an efficient drug. In order to produce the narcotic effect with the least interference with digestion, it would be better to give either dilute alcohol or diluted spirits rather than to give the wines.

CHAPTER XV

DIETETICS IN FEVERS AND INFECTIOUS DISEASES

A. FEVERS IN GENERAL

PRACTICALLY all infectious diseases are ushered in with fever. Sometimes the fever continues throughout the course of the disease until convalescence begins. On the other hand, fever, as a rule, means infection of some kind. It seems wise, therefore, to begin this discussion with a more or less detailed treatment of dietetics in fevers in general.

The practical advantage of this method of treatment will be evident as we proceed. When once the fundamental principle of dietetics in fevers in general is thoroughly understood, the application of these general principles to numerous febrile conditions found in the various infectious diseases will be only a matter of detail and will be simple.

The initial fast which should be instituted in all fever cases must be of varied duration according to circumstances. If the patient is well nourished before the onset of the fever, and if the illness is of a character which will probably not be of long duration, a fast of three days may not be too long. If, on the other hand, the patient is in a state of low nutrition, and if the illness is of a character where several weeks of duration may be expected, it is important to shorten the fasting period to a much lower limit, perhaps not over twenty-four hours. In many cases of beginning fever there is some nausea, in most cases a decided disinclination to eat. These are Nature's indices as to the rational course to take.

Water should be freely used during all fevers, but its use during the fasting period should be especially copious for several reasons. In the first place, the patient is certain to experience con-

siderable thirst. This is nature's indication of the rational treatment. The action of water in the system at this time is easily understood in the light of the preceding chapters. It is the most effective agent in the control of body temperature. It is the most effective agent in elimination of waste materials, whether these waste materials have accumulated in the intestinal tract or in the blood. If in the intestinal tract, the water facilitates free bowel movements; if in the blood, the water facilitates kidney activity and the waste materials are readily carried away. While pure water is probably the best drink that can be presented to the patient during this and the subsequent period, many variations may be instituted; such acid drinks as lemonade and orangeade may be freely given; weak tea and iced coffee may also serve as an agreeable change. One should never forget in this connection that the citrous drinks serve as stimulants both to kidney action and to skin action. In this stage of the case it is not unlikely that this stimulation is a much-desired effect to produce. Furthermore, tea and coffee act as stimulants to the nervous system. Such stimulation may be desirable, or the reverse. The dietitian will be governed accordingly.

Vomiting and nausea, whenever they appear as initial symptoms of an infectious disease, should be considered as an indication to be followed, and the fasting period should be continued so long as the vomiting and nausea remain.

The first food given to the fever patient should be *liquid.* Unless there are very good reasons to the contrary—as, for example, personal idiosyncrasy against it—this first liquid food should be milk. The almost universal choice of milk as the staple liquid food in the early stages of fevers is due to the fact that, as a rule, it is easily digested, non-irritant to the stomach, does not yield an appreciable bulk of unabsorbed material, and is rarely subjected to putrefactive changes within the intestines. Occasionally we find a patient who does not digest unmodified milk easily. In such cases a modification of the milk may readily be made. One of the best agents for this purpose when the milk is to be taken into the stomach is barley water, which may be added to the milk before it is taken. When thus treated the casein does not coagulate into curds in the stomach. Another modification of the milk is the ad-

dition of limewater to the extent of two ounces to a pint. This addition of limewater greatly facilitates the digestion of the casein. Sometimes the dilution of the milk with plain water is a sufficient modification. The addition of some flavoring material may make the milk more palatable, though it would not modify its digestion.

Beef juices or broths may be used freely and serve to break the monotony of the milk diet. (For recipes, see Appendix I.) Sometimes milk can be added to the broth, in which case the nourishment may be represented mostly by the milk—the broth furnishing the flavor.

Semi-solid foods may be introduced in most fever cases after the first few days. The indication for the introduction of semi-solids into the diet should be an evidence of the complete digestion and absorption of the liquid diet previously given, and an appetite on the part of the patient for something more substantial. The semi-solid foods are those which readily become liquefied either in the mouth or stomach as the result of mastication or rise of temperature or through the solvent action of saliva or gastric juice. Among these semi-solid foods may be named ice cream, fruit jelly, meat jelly, junket, custard, soufflé, and gruel. In all these, complete quick action in the mouth or stomach is insured. In the preparation of gruels cereals are used.

In order to make the cereals easy of mastication and of complete liquefaction after mastication, the greatest care should be used in their preparation. Hours of boiling may be necessary to reduce rice, barley, oatmeal, or other cereal meal or flour to the required condition. Cornstarch jellies, tapioca, and sago may also be so prepared as to belong properly to this class of semi-solid foods. The transition from liquid to semi-solid foods should be a gradual one, and these should be introduced into the dietary in such a way as to provide variety. As the patient enters upon his convalescence there should be an equally gradual transition from semi-solid to solid foods.

Solid foods may be understood to include any foods in the dietary which require to be ground by the teeth in order to reduce them to a semi-solid condition. In the choice of solid foods for a convalescent patient, one has usually a wide range and may

freely consult the likes and dislikes of his patient, not losing sight, however, of the importance of serving only such foods as represent considerable nourishment or such as have a laxative effect on the bowels. Meats, vegetables, fruits, and cereals may be freely used; they should always be served in small portions and prepared in such a way as to be easily digested. All attendants upon the sick should emphasize the importance of a very thorough mastication of the food. A convalescent patient cannot plead lack of time for that process.

Febrile albuminuria sometimes appears late in a fever case as a complication. Whenever this complication arises the diet should be at once modified and the patient put upon a strictly liquid diet, principally milk, until the symptom disappears.

B. INFECTIOUS DISEASES

Having thus described in some detail the principles to be followed in all fever cases, it remains now simply to apply these principles to the various infectious diseases. Those diseases which require no special individual dietary and which may be treated dietetically by a simple application of the principles just laid down under the above topic are here named:

Group I.—

Measles	Dengue
Mumps	Influenza
Malaria	Septicemia and Pyemia
Erysipelas	Cerebrospinal Meningitis
Dysentery	Pleurisy and Empyema
Scarlet Fever	Laryngitis
Small-pox	Acute Bronchitis
Typhus Fever	Pneumonia
Yellow Fever	Acute Articular Rheumatism.
Relapsing Fever	

In the case of *scarlet fever,* named in the above list, milk should remain the staple diet until after the scaling. Inasmuch as most cases of scarlet fever are among children, the milk diet is usually

relished and well borne throughout the period. After the scaling the patient may pass rapidly through the course of semi-solid, and after a few days begin the use of solid foods.

In the case of *rheumatic fever,* i. e., of *acute articular rheumatism* emphasis is here placed upon the importance of free use of the fruit juices. The influence of these has been thoroughly discussed above and there is no condition in which their influence is more important than in acute articular rheumatism.

Diphtheria requires a special discussion, though the choice of foods for diphtheria cases should be the same as that described above for general fevers. The condition of the throat in the diphtheria case introduces serious difficulties in the administration of food; soreness of the throat may seriously interfere with the swallowing even of liquid food and may even make recourse to nutrient enemata necessary for a short time. If intubation becomes necessary still further difficulty with the swallowing arises. The patient may not be able to swallow liquids at all. As a rule, the semi-solids and solids will be digested if they can be swallowed. Swallowing may be facilitated by lowering the head.

In severe cases of diphtheria there may be a paralysis as one of the later symptoms. If this paralysis involves the muscles of deglutition it will be necessary to introduce food into the stomach by means of a stomach-tube. The paralysis of the muscles of the larynx and base of the tongue will make the introduction of the stomach-tube especially easy.

Group II. Typhoid Fever.—Of all the infectious fevers, this one presents the greatest difficulty to the dietitian. The responsibility of the dietitian is greatly increased because of the fact that about the only treatment that can be given in the average typhoid case is the dietetic one. A further complication in the dietetics of typhoid fever is the fact that from the first the patient has no craving for food whatsoever, and the dietitian lacks the help that usually comes from the craving on the part of the patient. Furthermore, in typhoid fever there is usually a period of a week or ten days, called the ambulatory stage of the disease, when the patient's appetite is precarious and the nutrition more or less seriously disturbed. Therefore, when he finally takes to his bed and comes first under the care of the physician and nurse, his nutrition has al-

ready been so far interfered with that it is necessary to introduce nutriment into his system almost from the first. No food among the numerous ones that have been tested in typhoid fever has proved so satisfactory as milk, and this has for decades been recognized throughout this country and Europe as the staple article of diet in all the earlier stages of typhoid fever. Recently, however, we have come to recognize that with all its advantages milk has some serious disadvantages, and these are most in evidence in unmodified whole milk. The fact that it curdles in the process of digestion makes it distinctly more difficult to digest than its various modifications. Furthermore, the modifications are more pleasing to the appetite than straight milk. The most satisfactory modification is probably to be found in thin gruels. In the case of idiosyncrasy against milk recourse must be had to other liquid diet. Egg lemonade, egg-nog, and various similar preparations may be used. Beef juice, prepared as described above, may also be freely used.

As typhoid fever is the result of infection of the intestinal canal, those foods should be used which are almost completely digested in the stomach and duodenum and very easily digestible and completely absorbable. One of the greatest dangers in typhoid fever is that of perforation of the wall of the intestine. Should perforation take place all ingestion of food by the mouth must be suspended for a time. Any nourishment introduced must be in the form of enemata and these are sometimes contraindicated. Liquid foods must be continued in typhoid fever until the danger of perforation has passed and the patient is distinctly on the mend and convalescence practically established. There has uniformly been a considerable loss of weight and general depletion of the physical powers of the body. Convalescence is always a more or less tedious and prolonged affair. There is no part of the course of typhoid more important from a dietetic standpoint than the convalescent period. Throughout all the earlier part of convalescence semi-solid foods must be adhered to. When the appetite of the patient has returned he is ready to eat anything. If he were allowed free rein to his appetite he would almost certainly, through wrong choice of food or through overeating, bring on a relapse and the last condition would be worse than the first. From the

semi-solid foods given during the first seven or ten days of convalescence, a gradual transition can be made to such solid foods as cream toast, soft-boiled or poached eggs, baked potato, baked apple, boiled rice, etc. During the latter part of the second week of convalescence steaks and chops may be introduced into the diet, but the greatest care should be taken that all solid foods should be very thoroughly masticated before they are swallowed. After the second week of convalescence a little wider range may be allowed, but so long as the patient is under the care of a physician and nurse, and even for weeks afterwards, he should be abstemious in his diet.

Care of the Mouth.—The care of the mouth is a most important hygienic measure to observe in all fever cases, particularly so in typhoid fever. The tendency to the collection of sordes and heavy coating of the tongue tends to make the food tasteless and generally to disturb the comfort and well-being of the patient. Whenever the patient is able to do so without help, he should thoroughly cleanse the mouth, rinsing it in water or in half saturated boric-acid solution. This should be done not only just after meals with a view to removing all traces of food from the mouth, thus decreasing fermentation there, but also just before the meal the mouth should be rinsed. When the patient is not able to do this himself, and such will be the case during a considerable portion of severe cases of typhoid, this important function must be performed by the nurse or attendant, using either plain water, or better, boric-acid solution followed by plain water; the mouth may be thoroughly swabbed out with a gauze swab prepared by the nurse.

Group III. Tuberculosis.—Tuberculosis, particularly pulmonary tuberculosis, is an infectious disease in which the metabolism of the body is more or less seriously disturbed. One of the first symptoms diagnostic of tuberculosis is a more or less continuous fever with progressive loss of weight. This symptom is, of course, likely to be accompanied by such local symptoms as coughing, and, with the more severe onset of the disease, even hemorrhage from the lungs. Once the tuberculous infection is established, and the disease has reached the point indicated by the above-named symptoms, the situation is a serious one and requires the most assiduous

attention, with a radical revision of the hygiene, with a view to making it as nearly perfect as possible.

Experience of recent years seems to indicate that about the only remedial treatment that is effective is in the direction of perfect hygiene. The two most important phases of this hygienic treatment are, first, *absolute purity of air*, and second, *ample nutrition.* The first is accomplished most effectively and satisfactorily when the patient remains continuously out of doors. If in the house at any time in the day, he should always be in a room whose ventilation is as nearly perfect as possible. Coldness of the air is rather advantageous than otherwise, and we find tuberculous patients sleeping out of doors, on back porches, sleeping balconies, in tents, on roofs, or under specially devised window awnings.

This régime of the tuberculous patient naturally requires no small amount of heat-producing food, as the draft upon body temperature is very considerable in this out-of-door life.

Furthermore, the continuous fever experienced in the earlier active stages of the disease is associated with a more or less extensive breaking down of vital tissues, as well as the consumption of the fat reserves. If this consumption of tissue is not early checked, extreme emaciation will certainly follow with a serious embarrassment of all the forces of the system in vitality, strength, and resistance. The most that physicians and attendants can do for tuberculous patients, as a rule, is to assist their physical resources in combating the infection. If this can be successfully accomplished for a few months, the chances are favorable to a successful healing up of the local infection, and a recovery more or less complete.

Next in importance and hardly less important than securing of absolutely pure air for respiration is the insuring of a large amount of food assimilation. The object of this is to make good the waste resulting from the fever; fortunately, as a rule, tuberculous patients have fairly good digestion, and so long as this condition lasts the dietetics present comparatively simple problems.

The principal problem in the dietetics of tuberculosis is to get as much nourishment as possible assimilated. Many devices have been utilized; a few years ago a popular treatment consisted in

the use of inordinate quantities of milk and raw eggs and scraped or hashed raw beef. If a patient were able to take this food with a relish for a considerable time there would be no reason to criticise it. However, the fact of the matter is that most patients will find such a diet exceedingly distasteful after a few weeks and then will begin to long for other foods. Recourse must, of course, be had to other foods, and the appetite having been spoiled for milk, eggs, and raw meat, these most valuable adjuncts of the diet will have to be cut out for weeks or even months.

A very much wiser course to pursue would be to put the patient upon a general mixed diet from the first, introducing as large a proportion of milk, eggs, and choice meats as can be done with certainty that the patient's craving for these foods will not be interfered with. While it is true that whole milk is more nourishing than skimmed milk, some patients find it less easy to digest. When this is the case skimmed milk may be resorted to. However, it is wiser to try first the addition to the whole milk of limewater or such other diluent as barley water. The predigested milk, as peptonized milk, should not be used. As a general rule, predigested foods should only be used for very acute conditions, lasting only a few days.

While raw eggs are more easily digested than cooked eggs, they are so distasteful to most people that it would be much wiser to cater to the appetite than to any theoretical consideration regarding ease of digestion. We have learned in preceding chapters that the appetite is a primary consideration in the ready digestion of food. Soft-boiled eggs, seasoned with butter and salt, may appeal very strongly to an individual who would be nauseated with a raw egg. If the gelatinous white of the soft-boiled egg is masticated perhaps with dry bread until it has been reduced to a creamy consistency and actually disappears almost unconsciously from the mouth as it is thus reduced, we cannot conceive any reason why eggs thus prepared and eaten should not serve in the body the same purpose as the raw egg. As a matter of fact, the author believes that it will serve the needs of the body incomparably better than raw egg taken under protest. There are several methods of taking raw egg, which may be introduced as variety, especially if they are pleasing to the patient. Egg beaten

up and mixed with milk—one egg to a half pint, and slightly flavored, as with vanilla or nutmeg—makes a very pleasing drink and may be introduced not infrequently as a variation of the diet. Light custards of milk and egg are very pleasing to most people, and when properly made are very readily reduced to a fluid state by mastication. Scrambled eggs, omelets, may also be introduced for variety, but the same precautions must be observed in their mastication as was suggested above in the use of boiled eggs.

As to meat, this should be taken very much more freely than a person in ordinary good health would take meat. While once a day would be considered quite enough for an ordinary person in good health, it is considered wise to introduce meat at least twice in a day for tuberculous patients. Care should be taken to choose the best quality of meat, whenever the patient is in a position to afford the cost of the choicer meats. The choicer cuts of steak and of mutton, broiled, are probably the best form in which to serve the heavier meats. Chicken may be roasted or fricasseed; fish may be boiled or baked. A few years ago it was customary to reduce meats to a pasty condition by grinding, and to cook them as little as possible. The use of meat in this condition is almost certain to have the same effect on the patient's appetite after a few weeks as would the ingestion of raw egg. The meat must be cooked in order to develop in it the flavors pleasing to the average appetite.

It goes without saying that if cooked meat is cut up into chunks and swallowed whole it might embarrass the digestion, but there is no rational indication for doing by machinery the work that is supposed to be done by the teeth. As a rule, the tuberculous patient can spend a full three quarters of an hour at his heavier meals. His meat should, in common with all the rest of the food which he takes, be reduced to a thin creamy condition by a thorough chewing and mixing with the saliva before it is swallowed. If it is thus finely divided by the teeth and mixed with saliva it will be very much more fully enjoyed by the patient, very much more quickly and easily digested, very much more completely absorbed and assimilated than if chewed by machinery.

As to the use of fats it must be evident from what has preceded that the free use of this type of food is indicated especially

to afford the heat required to keep up body temperature in the out-of-door life, especially during those hours when the patient is asleep out of doors. The most easily digested fat being milk fat, the patient should use whole milk if possible, and should use cream freely with the cereals, vegetables, and fruits. Butter may be introduced very freely into the dietary. It may be used with eggs; it may be used on bread and with vegetables, and even be spread upon a steak or chop as it comes smoking hot from the grill. The fat from bacon is comparatively easily digested and two or three slices of crisp brown bacon may be eaten at breakfast.

Vegetable fat in the form of olive oil may also be taken freely. This fat is perhaps more easily digested if it is made into an emulsion before taking. The most pleasing emulsion of olive oil is made with the yolk of a hard-boiled egg in the form of a mayonnaise. Mayonnaise dressings are very palatable to most persons and there is no reason why they should not be taken very freely by tuberculous patients, as a dressing for spinach or other greens, or for tomatoes or lettuce.

As to carbohydrates, they must be taken freely, but considerable care should be taken in the choice and in the preparation. Green vegetables and fruits furnish only a moderate amount of carbohydrates and can hardly be looked upon as an important source of carbohydrate food for consumptives. It is important, however, that these patients have plenty of fruit and at least one dish of vegetables daily. All fruit that is taken fresh should be very carefully selected, and should be thoroughly ripe. Grapes may be used freely, pears, peaches, oranges, plums; among the green vegetables, such easily digestible things as cauliflower, spinach, ripe tomatoes, green corn, green peas. Care should be taken in the selection of these; they should be thoroughly cooked, and may be served with butter or cream sauce.

A much more important source of carbohydrates is found in the roots and tubers; the white potato is a staple source for starch and may be used freely by the consumptive patient. The best method of preparing it is baking or boiling. All fried foods should be excluded from the diet of the tuberculous patient.

The cereals furnish not only an important source of carbohydrates but also of the proteins. These foods may be used freely.

Such preparations as oatmeal porridge, the various wheat and corn preparations, may be taken for breakfast with sugar and cream. Bread is the most important staple article of diet from cereal sources. The importance of keeping the bowels regular leads one to advise the use of the coarser breads, such as whole wheat and graham bread. All hot breads, and particularly those made from the fine white flour, should be strictly prohibited, because of the difficulty of their proper mastication and insalivation.

Among animal fats cod-liver oil is a time-honored source, especially important because of its easy digestion. It becomes very readily emulsified because of the presence in the fat of biliary acids; their presence perhaps also increases the easy absorption. Cod-liver oil is a valuable addition to the diet, especially for tuberculous children, and whenever given it should come about two hours after the meal, when it will be quickly carried through the stomach into the intestine, from which it is readily absorbed. For adults who have a fairly good digestion it is doubtful if cod-liver oil has any advantages, particularly if it is distasteful.

A day's régime for a non-febrile case may well begin with the drinking of two cups of hot water an hour before breakfast. This water will pass out of the stomach before breakfast.

All collected mucus passes out along with the water to lubricate the contents of the canal and facilitate a free normal passage of the bowels after breakfast. The breakfast may consist of buttered toast, two soft-boiled or poached eggs, a baked potato, two or three slices of bacon, and a cup or two of hot drink, preferably whole milk flavored with coffee or tea. The use of these stimulants in greater amounts than just sufficient to flavor the milk may interfere with digestion, and, because of this danger, it is wiser to run no risks. After this ample breakfast, the patient may lie down on a couch in the sunshine. If it is on a veranda and the weather is cold, the patient should be sufficiently bundled up to keep him comfortably warm. If within a sun parlor, or inclosed veranda, one should make certain that the ventilation makes the air practically as pure as that out of doors. After half an hour to an hour's rest the patient may engage in some very light exercise for an hour. If he is able to take a ride in a carriage this would probably be about the best form of exercise. If he has no carriage he

will have to be satisfied with walking around the block. He should, during the rest of the morning, occupy his mind with anything that will divert his attention from himself. He may be obliged to look after some business affairs, or, in the case of a mother who is unable to get away from her family, this is the time of day when she can devote an hour or two to such duties and responsibilities as cannot be shifted to other shoulders. However, if there is a possibility of relieving the tuberculous patient during a few months from all responsibility and necessity for mental or physical work, that should by all means be done. Assuming that the patient has been thus relieved, we will suggest, then, as a morning occupation after the sun bath and the light exercise, reading. This reading should be chosen with some care with reference to occupying the mind fully, at the same time affording entertainment and diverting the attention from the patient himself. At one o'clock lunch may be served and may consist of a cream-of-vegetable soup, fricassee of chicken with boiled potato, whole wheat bread and butter, gelatin pudding with whipped cream, a glass of whole milk iced. It may be stated in this connection that all drinks should be sipped and not gulped. This is especially important in the taking of cold drinks, as the iced milk just mentioned. If a whole glass were taken in half a dozen swallows, it is not unlikely that it might seriously interfere with the work of the stomach; but if taken a sip at a time, held in the mouth, and mixed with saliva, so long as it retains its taste until it gradually slips down the esophagus almost without the knowledge, surely without any conscious effort on the part of the patient, then the milk will be very easily digested and will not form large curds in the stomach.

After lunch the patient repairs to his couch again and rests quietly, dozing, if possible. He may combine this rest, as he did the morning rest, with a sun bath. After his rest, if the weather is not inclement, he may take a little walk around the block and read an hour or so. If the period between lunch and dinner is more than five hours, the patient may feel, late in the afternoon, a craving for some nutriment. If so, something like an egg lemonade should be served. The egg in this drink is already half digested, and will be readily peptonized in the stomach and the food wholly absorbed or passed out of the intestine before the

next meal. Many variations of the egg lemonade have been devised and may be substituted for it by way of variety. The introduction, however, into this afternoon refreshment of food that requires one or two hours' work on the part of the stomach in order properly to digest it, should be strongly discouraged. It overtaxes the stomach, and, in the long run, the patient will not assimilate as large an amount of food as he would if confined to three square meals a day. At 6 or 6:30 o'clock dinner may be served. This is the most elaborate meal of the day. While the breakfast and lunch were served individually in the patient's sun parlor or inclosed veranda, the dinner should, if possible, be taken with the family. Of course it goes without saying that the strictest sanitary precautions must be observed as to the use of dishes, napkins, etc. However, this can easily be arranged in any family where there is intelligent coöperation. The family may have a sirloin steak for dinner. There is no reason why the patient should not have his portion of meat from this general steak; or mutton chops, or roast leg of lamb, or roast chicken, baked fish, or roast turkey. If, however, the family menu provides pork and beans, or roast pork, or breast of veal with dressing, the patient should have a special provision of meat, such as a mutton chop or a bit of tenderloin steak. The meat having been provided, the patient may partake of the general family menu of boiled or baked potato, a side dish of spinach with egg garniture and mayonnaise dressing, whole wheat bread, butter, stewed prunes, or other stewed or canned fruit. When the family has its coffee the patient may have a cup of hot milk flavored with coffee. For dessert, a cup custard or a cup of junket, or gelatin pudding with whipped cream, may be served to the family as dessert, in which case the patient may partake of the general menu. If, however, the family indulges in mince pie or other rich pastries and puddings, the patient must abstain from these and be satisfied with a simple light dessert; perhaps a bunch of grapes will suffice.

Forced feeding is sometimes advisable in the case of pulmonary tuberculosis, when there is loss of appetite with tendency to nausea when food is swallowed under protest. A study of these cases has shown that the difficulty is in the nervous system rather than any inability on the part of the digestive system to digest the food,

Food once in the stomach will be digested if it does not cause nausea and vomiting. If it can be introduced into the stomach without the necessity of chewing and swallowing it, no nausea will occur, and the food will be digested, absorbed, and assimilated. The usual method is to introduce liquid foods through the stomach-tube. This permits a much larger ingestion of food than could be accomplished by rectal feeding.

CHAPTER XVI

DIETETICS IN DISEASES OF THE DIGESTIVE SYSTEM

We found from the previous chapter that in infectious diseases the dietitian has to deal with disturbances of the metabolism, while the digestive system is, as a rule, in a fairly normal condition and able to digest a sufficient amount of food to keep the system sufficiently nourished. In the treatment of diseases of the digestive system, however, the physician and attendants are confronted by difficulty of another character. Any disturbance of metabolism is purely secondary; it is the gateway to the nutrition that is out of order, and diseases of the digestive system, whether they are functional or organic, interfere with the processes of nutrition at the very outset. Aside from pain sometimes experienced in various disorders of the digestive system, the principal symptoms are those associated with the incomplete digestion and absorption of food.

In a general way, the cause of diseased conditions of the digestive system is bad hygiene. For example, overeating, irregularity of meals, bolting the food, or failure properly to masticate the food, and wrong choice of food. Other conditions not conducive to normal work of the system, such as heavy work, either physical or mental, immediately following heavy meals, or the reverse, the eating of a heavy meal immediately following exhausting work. The rational treatment of the digestive system should always begin with a study of the cause of the condition in a particular case. Once the cause is determined, it should be removed. This alone would in a considerable proportion of the cases lead gradually to a regaining of the normal condition. Any loss of weight in these cases is very likely to indicate a failure to assimilate a sufficient amount of food, while in the group of cases discussed in the pre-

ceding chapter loss of weight indicated increased metabolism beyond the normal.

A general rule may be set down for all these cases of disturbance of the digestive system: If the condition is very acute in its onset and if the patient is in a well-nourished condition, when overtaken by the disease, the best initial treatment would be a complete rest for the digestive system for a period of forty-eight to seventy-two hours. In the chronic cases and all cases that begin very gradually, the physician and dietitian are not called in until there is already a considerable disturbance of nutrition, usually with decided loss of weight. In these cases the initial fast is contraindicated.

A. GASTRITIS

Acute Gastritis.—The most important symptom in acute gastritis is nausea and vomiting. Following the general principle stated above in all acute conditions where nausea and vomiting are symptoms, there should be a complete cessation of all ingestion of foods for a period of two or three days. The patient's thirst may be slaked either by ingestion of very small amounts of pure cold water taken every thirty minutes, or if this is not borne by the stomach, enemata of normal saline solution, as described in a previous chapter, may be used.

The dryness of the mouth and throat may be relieved by taking sips of cold water or small bits of ice into the mouth, but permitting none of the liquid to pass into the stomach. After two or three days it will be found that a small amount of water may be swallowed without causing any nausea. From that time on very moderate ingestion of liquid foods may be allowed, not more frequently than once in two hours, beginning with peptonated or limewater milk, or egg lemonade, giving not more than one or two ounces at intervals of two hours during the first day, increasing the quantity in three-hour intervals the following day, and gradually, as the days go by, increasing both in quantity and interval, passing gradually from liquid into semi-solids, and finally into solid foods, and three square meals a day. It goes without saying that in acute gastritis, even after the stomach has proven

itself able to retain and digest solid food, one should avoid the ingestion of anything that can irritate the stomach, or any food difficult of digestion. All condiments, alcoholic drinks, strong tea and coffee, and vegetables possessing a large proportion of cellulose, are contraindicated until health is thoroughly established.

Chronic Gastritis.—This condition of the stomach differs from acute gastritis in several important respects. While acute gastritis is strictly a functional disorder, the chronic gastritis is associated with pronounced organic change of the stomach, taking the form of a thickening of the mucous membrane. Chronic gastritis begins gradually and can usually be traced in its origin to the habitual ingestion of irritating substances. It is probable that in the vast majority of cases the irritating substance is alcohol. Chronic gastritis is more frequently associated with chronic alcoholism than with any other condition. When the case comes to the physician and dietitian there is already a serious disturbance of nutrition. The absolute contraindication of any further ingestion of alcohol is the first thing to be recognized. The stomach needs water. Swallowing of water is very likely to be associated with nausea and vomiting; this may be avoided in a large part by gastric lavage. The technic of gastric lavage has already been described above. It should be done at least once each day, preferably in the morning before breakfast. The foods first presented to these patients should be predigested proteins, mixed with fats and sugars. The food that most nearly fulfills this requirement is peptonized milk. Such food leaves the stomach little to do. The peptonized milk does not form curds and passes presently through into the duodenum, where the digestion of the fat is accomplished and the lactose is split up, after which it is ready for absorption as to all of its constituents. After two or three days of the use of peptonized milk, milk and limewater may be presented, followed by milk diluted with barley water or oatmeal water. From these liquid foods gradual variety and change may be introduced through the use of meat juices, broths thickened with thoroughly cooked cereals, egg lemonade, and delicate custards and gelatins, gelatin and whipped cream, and so on through the list of easily digested semi-solid foods merging into the easily digestible solid foods. As the semi-solid and solid foods are introduced into the dietary the

greatest care should be observed in their mastication. The perfect mastication and insalivation of every mouthful should be insisted upon. If the patient does not know how to accomplish this, then he should be taught. Two general rules should be observed as the patient begins the use of semi-solid and solid foods—namely, first, to eat small amounts; second, to eat regularly. Among the things that should be rigidly excluded from the diet, the following may be named: Coarse vegetables, candies, pastries, fried foods, as fried potatoes or fried eggs, cakes, puddings, spices, condiments, alcohol, hard-boiled eggs, lobster, and any substances against which the patient is known to have an idiosyncrasy.

In some cases of gastritis there is a profuse secretion of mucus, in others a profuse and continuous secretion of hydrochloric acid, in others a diminished secretion of hydrochloric acid, and still others a wholly suspended secretion. These four special phases of chronic gastritis may merge one into the other. They are technically called *mucous gastritis, hyperchlorhydria, hypochlorhydria,* and *achlorhydria.*

Mucous gastritis, characterized by an abnormal amount of mucous secretion in the stomach, is best treated by gastric lavage, and this is most effective when done the first thing in the morning before any food is taken. After a short period of the lavage through the stomach-tube it may be possible to accomplish a natural lavage through the ingestion of a pint of cold water one hour before breakfast. This differs essentially from the artificial lavage in that it forces the mucus and water into the intestinal tract instead of siphoning it out. Natural lavage is always to be preferred to artificial lavage, when it is possible to get the normal result—that is, when the contents of the stomach actually pass into the duodenum within an hour. It goes without saying that no food should be taken into the stomach until this has been accomplished. The test as to whether or not the stomach is empty one hour after the drinking of a pint of cold water can be made by introducing a stomach-tube filled with water and clamped until the end of the tube is within the fundus of the stomach. By lowering the outer end of the tube following the method of siphoning in artificial lavage, the contents of the tube, together with any liquid in the stomach, will be siphoned out. If the stomach

is empty only the contents of the tube will be returned, together with perhaps a few drops of just secreted mucus. If a quart or more of slimy mucus is siphoned off, that will be a proof that the natural lavage has not run the intended course and that the stomach has not been emptied. After the morning lavage, whether artificial or natural, the breakfast may be taken. The same general dietetic régime will be followed in mucous gastritis as in acute gastritis just described.

Hyperchlorhydria is characterized by greatly increased secretion of hydrochloric acid. While it is a form of gastritis that may follow the excessive use of alcohol, still it is also caused by overeating, by improper mastication, or by the interference of digestion through worry, nervous shock, or fatigue. Some physicians give large quantities of proteins such as raw or soft-boiled eggs, or lean meat, with a view to the using of all the hydrochloric acid in its combination with the proteins, to form acid albumin, the idea being that the acid albumin thus formed is less irritating to the mucous membrane of the stomach than the free hydrochloric acid. While this is quite true, it is also true that the ingestion of a distinctly protein diet serves as a stimulus to the secretion of not only the acids but pepsin, as has been amply demonstrated in the recent work of Pavlow. In order to avoid the stimulating influence of the presence of a large amount of proteins in the stomach, a more rational dietary would be one in which the three organic foods have practically their normal balance. During the period of hyperacidity, the ingestion of milk diluted with limewater, or with alkaline effervescent mineral water, may be used for the first few days of the dietetic treatment. From this initial treatment the diet may pass through gradations of semi-solid and solid foods, following the same general principles as outlined under Chronic Gastritis. In the case of complete loss of appetite, attended with nausea, when food is taken under protest, forced feeding or gavage may be followed in this case as in a similar condition in the consumptive. The same care should be taken in these cases as in chronic gastritis to avoid all such irritating foods as those named under Chronic Gastritis.

Hypochlorhydria.—As the name suggests, this condition is characterized by a diminution of the hydrochloric acid and is

likely to occur as a sequel to the condition just described. As the hydrochloric acid is an essential in gastric digestion of proteins, its diminution decreases the quantity of proteins possible for the stomach to digest. On the other hand, the presence of proteins serves as a stimulus to gastric secretion, and they should not be markedly diminished in the diet. However, in this condition, more than in the preceding, the interval between meals should be sufficiently extended to insure not only the digestion of foods and their passage from the stomach into the duodenum, but also a period of rest for the stomach. Some physicians hold to the advisability of assisting the stomach by administering hydrochloric acid. When this is done it should always be administered not earlier than one hour after the meal. If it is administered with the meal its presence in the stomach will have an inhibitory action on gastric secretion. For similar reasons, any fruit acids, as lemonade or egg lemonade, taken at or near the mealtime, should always be at the end of the meal, or, better yet, half an hour or an hour after the meal.

Achlorhydria, characterized by the entire absence of hydrochloric acid, makes it quite out of the question for the stomach to bring about the digestion of proteins. When we remember that there is a provision for the digestion of proteins in the duodenum through the trypsin of the pancreatic juice, it becomes evident that if we can so control the conditions as to cause a passing of the food through the stomach into the intestines, it will be digested there. This can only be accomplished by ingesting into the stomach liquid foods which remain liquid in the stomach. If milk were ingested the rennin of the gastric juice would coagulate it, but it could not be digested on account of lack of the hydrochloric acid to initiate the process on the coagulated casein, so unmodified milk is distinctly contraindicated in achlorhydria. Peptonated milk may serve as one article of diet; gelatin, cream, butter, bacon, olive oil, all may pass through the stomach without change and are digested in the small intestine. Carbohydrates, especially cereals, cooked to the point of liquefaction may pass through the stomach with practically no change and be completely and easily digested and absorbed in the small intestine. Such carbohydrate foods as zwieback or buttered toast may also be

used, but the precaution must be positively observed of masticating these foods until they are absolutely liquefied into a smooth liquid in which one is not conscious of any solid particles. When thus liquefied these foods may pass readily through the stomach without causing irritation, and be completely digested in the small intestine.

In several of the foods above mentioned—viz., the cream, gelatin, and the cereal—there is a certain amount of undigested though liquefied protein. The presence of this protein in the stomach will serve as a mild stimulus to the gastric glands, and it is perhaps through this stimulus, as much as from any other cause, that the secretion of the acid is begun again by these glands.

B. DILATATION OF THE STOMACH

This condition may be caused by habitual excess in eating and drinking, or it may follow such general conditions as neurasthenia, or anemia, in which conditions there is a progressive weakening of the muscles, or it may be caused by a mechanical stoppage of the pylorus, as in the case of pyloric stenosis or the growth of a tumor in the vicinity of the pylorus. From any of these causes the condition is a serious one. The interference of the passage of foods from the stomach into the intestines necessitates the reduction of the quantity which is to pass through the pylorus to the smallest proportions. Yet the food given must be such as can easily be liquefied and digested in the stomach. The rational indication is for highly condensed solid foods, which must be very thoroughly masticated before they pass into the stomach. If the food remains in the stomach a considerable time, fermentative and putrefactive changes may begin. This introduces another reason for the use of condensed easily digestible foods in smaller quantities. If there is evidence that fermentative or putrefactive changes have taken place, then the stomach must be washed out, completely freed from the products of fermentation.

The free use of beverages should be discouraged, as they tend to aggravate the dilatation. Sugars should be prohibited, as they have a tendency to easy fermentation. Any of the better grades

of meat, such as beefsteak or roast, mutton chop or roast, fish, fowl, or game, may be used. Any of the cereals thoroughly cooked may be used, also the legumes. Care should be taken to introduce with these foods no coarse, chaffy, and scaly material with the cereals and no bits of bone or gristle with the meats, as these are wholly indigestible, and may clog a narrowed pyloric opening, besides serving as an irritant to a sensitive mucous membrane. Soft-boiled or raw egg, stale bread, toast, zwieback, are in order. A general rule to be always observed in these cases is that no food should be swallowed that has not been completely masticated and mixed with saliva. Even foods that are taken into the mouth as fluids should be sipped in small quantities and held in the mouth until thoroughly mixed with saliva before they are swallowed. This holding of the food in the mouth, tasting and mixing it with saliva, is one of the strongest stimuli to normal gastric activity.

C. ROUND ULCER OF THE STOMACH

This condition is characterized by great irritability of the stomach, pain due to the irritation of the denuded surface, and vomiting of blood which issues from the denuded surface. The most rational treatment for this very serious condition is a course of rectal feeding for a period of about ten days following the general directions given above for rectal feeding. Following the period of rectal feeding will be a period of milk diet for, say, ten days. The milk must be modified in such a way as to hinder the formation of leathery curds from the coagulation of casein. This can perhaps best be accomplished by the addition of limewater. This addition of limewater serves a double purpose. In the first place it hinders the formation of large leathery curds; in the second place, by its alkalinity it neutralizes in part the excessive acid of the stomach. If the milk is brought to a boil before the limewater is added, that seems to increase its digestibility. After the first few days of modification of the milk in this way it may be varied by the addition of cereal waters, as barley water, oatmeal water, etc.; then, as a further transition, by addition of enough thoroughly cooked cereal to the milk to make a thin gruel. This

may be followed by the introduction into the dietary of buttermilk, purées, gelatin combinations, custards, and other semi-solid foods.

The same principle must be observed here as has been emphasized above—namely, the slow sipping and tasting even of the liquid foods. Such foods must never be gulped down, quickly draining the glass, but they should be taken, small quantities at a time, held in the mouth, mixed with saliva, tasted, warmed to body temperature before they are swallowed. Ever so small a quantity would best be swallowed in two or three installments.

D. CANCER OF THE STOMACH

This condition is, of course, a most serious one. The growth is likely to be near the pylorus and seriously to interfere with the passage of foods through that opening. When the condition is associated with a dilatation of the stomach, the treatment is as above outlined under that head. When gastric digestion is altogether suspended through the influence of the condition, rectal feeding must, of course, be resorted to. Where the gastric digestion is only moderately interfered with, a régime similar to that outlined above for round ulcer of the stomach may be followed.

E. DISEASES OF THE INTESTINES

The term enteritis is applied to the inflammation of the intestinal mucous membrane. The condition is analogous to gastritis and is divided like that into the acute and chronic condition.

Acute Enteritis.—Acute enteritis, usually caused by the presence in the intestines of some strong irritant, or the presence of a mass of undigested food, should be treated dietetically, as in all these acute conditions, by an initial fast. No food should be taken into the alimentary canal for a period of one to three days. Water may be ingested in considerable quantities. This free use of pure water has the great advantage of soothing and healing the inflamed intestinal membrane, and of flushing out the general system. Any absorbed products of intestinal fermentation are quick-

ly flushed out of the system through the kidneys by this free use of water. If the acute condition is associated with a tendency toward constipation, free evacuation can be instituted through a course of calomel. After the initial fast the nutrition may be maintained throughout the rest of the course of the disease by the use of semi-solid and solid foods, following the general principles set forth above.

Chronic enteritis has a slower, more gradual onset than the acute, but has, in a general way, the same cause. In order to avoid an aggravation of the condition, the first dietetic rule is strictly to prohibit the ingestion of the following things: beer, wine, salads, fruits, especially those with a large amount of coarse pulp or seeds; vegetables, particularly those with much cellulose; pickles, acids, candies. To sum up the dietetics of chronic enteritis in a nutshell, we will quote the pithy formula of Dr. Edwards, of Chicago: "Simple foods, in small amounts, and at frequent intervals, controlled by frequent examination of the feces." This frequent examination of the feces is necessary to determine whether or not the ingested foods have been properly digested and absorbed. If the diet given has been properly digested and absorbed, then one is justified in proceeding along a similar line, perhaps slightly increasing the amount and the range of variety. If the contrary is shown, then a greater simplicity and greater restriction of the diet must be observed, choosing very easily digested, perhaps for a time actually predigested, foods.

Intestinal ulcer, when this is duodenal, should be treated as described above for gastric ulcers. The intestinal ulcer of the lower portions of the small intestine resulting from typhoid infection is sufficiently discussed under Typhoid.

Intestinal Obstruction.—Intestinal obstruction may be due to intussusception, stricture, tumors, or foreign body. Naturally, where the obstruction seems to be complete, the case is a very serious and urgent one, and the best preliminary procedure, so far as diet is concerned, is to stop all ingestion of foods until the physicians and surgeons have decided as to the procedure. If it is decided to operate at once, the usual diet for laparotomy cases will be adopted. If the obstruction is not complete, especially if no surgical interference is decided upon, the diet should be reduced to the lowest

terms compatible with proper nutrition of the patient, and the same diet should be used as in stricture or other partial obstruction of the pylorus—namely, condensed diet with all foods reduced to liquid before they are swallowed, being either liquid in their preparation or reduced to liquid by mastication. The same care should be observed that no indigestible masses of food, such as bone, gristle, etc., gain entrance to the alimentary canal. Food thus carefully selected will be largely absorbed before it reaches the obstruction. The remaining small portion of unabsorbed material will gradually make its way past the obstruction a few drops at a time. Naturally, the amount of material accumulated in the large intestine and rectum will be very small, and there is likely to be a little disturbance of the regularity of bowel passages. If this is the case, the colon should be flushed as frequently as once in forty-eight hours in order that there will be no accumulated waste materials there to be reabsorbed.

F. DISEASES OF THE LIVER

This organ is subject to several degenerative changes, as fatty degeneration, fatty infiltration, cirrhosis, etc. It not infrequently happens that there is a tendency to the accumulation of biliary concretions in the gall-bladder or ducts leading from it. This condition of biliary calculus, or gall-stones, is among the diseases of the liver. The liver is too far from the main line of traffic in the alimentary canal to be directly influenced by the diet. There are, however, certain general principles through whose help we may be able indirectly to ameliorate the condition and assist the system in its struggle to regain the regular normal condition.

In an earlier chapter, under Metabolism, the function of the liver in its relation to metabolism was rather fully discussed. We may recall here how the liver, among its various functions, is called upon to oxidize toxic substances absorbed from the intestines; such substances, for example, as result from overdigestion or fermentation of protein foods, also ethyl alcohol and other toxic substances ingested with the food. When these are absorbed they pass through the liver and are oxidized by that organ as a defensive

measure to protect the general tissues of the body against their toxic action. Now, if the liver is diseased by any of these degenerative processes mentioned above, its oxidative action will be interfered with. This fact makes it a matter of very great importance that in all cases of diseased liver care be taken that no alcohol or other toxic substances be ingested with the food. Furthermore, the proteins of the diet should be reduced to a minimum. This reduction of proteins will not only decrease the tendency to protein fermentation in the intestines, but will decrease the amount of the midproducts of protein metabolism that come back from the muscles to the liver to be prepared for excretion.

Regarding carbohydrates, these are elaborated in the liver, being deposited as glycogen, then later changed back to sugar, as described under Liver Metabolism. There is no doubt that in extreme cases of liver degeneration, carbohydrate metabolism in the liver is interfered with. From these general principles, it is evident that, in cases of liver degeneration, the proteins and the carbohydrates of the diet should be distinctly decreased in quantity; in fact, decreased to the minimum compatible with the proper nutrition.

In the case of gall-stones, however, a somewhat different set of conditions confront us. Here there is no interference with the oxidative action of the liver, nor with its glycogenic and glycolytic action. The diet, then, for the gall-stone case need have no great reduction of protein and carbohydrates. With fats, however, the situation is different. The presence of fat in the duodenum stimulates a more copious secretion of pancreatic juice, and this, in turn, stimulates a more copious secretion of bile. If the passage of bile from the gall-bladder or bile vessels is interfered with, the pain and other disturbance will be increased with an increased volume of the secretion. It is, therefore, universally recognized that in all cases of gall-stones the fats should be eliminated from the diet. Another rational reason for their elimination is that decrease of the bile in the small intestine will decrease the efficiency of digestion and absorption and lead to a loss of considerable portions of fat. Therefore, ingestion of fat would be from an economic standpoint useless. In cholecystitis increased volume and decreased viscosity of bile is advantageous; therefore, fat may be used.

CHAPTER XVII

DIETETICS IN DISORDERS OF NUTRITION

A. OBESITY

In an earlier chapter we discussed the deposit of food reserves in the system. It was there set forth that whenever the amount of food taken into the body exceeded the requirements of the body, the excess is deposited in the form of fat. This plan of nutrition is true for mammals, birds, reptiles, and fishes. It is true, in fact, for all animals above the lowest orders of marine animals. The evident purpose of nature is to store up excess in time of plenty against the needs of a time of famine. In their natural state and subject to the natural conditions, such animals as the ox, the deer, the bear, and the horse lay on a heavy coat of fat in the summer and autumn, which will serve during the winter the double purpose of an overcoat and a supply of fuel.

These general facts of biology make it clear that whenever the human subject has an excess of nutrition the body will store this up against the time of need; this is all in harmony with natural law. When, however, this law is applied to the human subject, it results in an abnormal condition, because ordinarily the human subject has plenty all the time. He does not go into a state of hibernation as does the bear, nor does he have to put up with one scanty meal a day dug out from under the snow, as does the deer, or the ox, or the horse in a wild state. So his accumulated fat is retained, only to receive additional installments as the period of plenty continues. Thus nature's wise and conservative provision may become for man an actual calamity. This condition, which may be looked upon in its more serious excesses as an actual disease, can only be corrected by applying nature's method. This

has been understood for ages long, and we have records dating back hundreds of years which show that long ago the condition and its significance was clearly understood. As far back as the days of William Harvey, the Elizabethan physician who demonstrated the circulation of the blood, we have a record of his treatment of the case of a patient named Banting. This method has ever since been known as the *Banting Method.* It would perhaps more appropriately be called the Harvey Method. According to that method the total amount of solid foods was reduced to not over a third of the usual amount—that is, twenty-one to twenty-seven ounces of solid food per day. Of this, lean meat comprised at least half; bread was reduced to the small amount of two ounces per day, and the balance of the bulk was made up of fresh fruits and vegetables. A drink allowance was limited to thirty-five ounces a day. All sugars and fats were absolutely eliminated from the dietary. This Banting diet, devised by Dr. William Harvey, represents about 1,100 to 1,200 calories per day. It will be remembered that the calory value of the usual diet figures up from 2,500 to 3,000 per day. Harvey reduced this to considerably less than one half; in fact, nearer one third of the usual average.

Oertel modified the Banting régime by allowing some fat and a slight increase in the permissible fluid ingestion. Oertel's diet produced about 1,200 calories, still considerably less than half the average.

Ebstein went a step further in the use of fats and permitted them to be taken freely, limiting only the proteins and carbohydrates, especially sugars and starches among the latter. Tea was allowed as a beverage. Ebstein's dietary represented about 1,400 calories.

Van Noorden's dietary, more recently planned and far more widely used than any of the others of the present time, will be here given in some detail (taken from Osler's "Practice").

BREAKFAST.

Lean meat, 80 grams.
Bread, 25 grams.
Tea, one cup with milk, no sugar.

MORNING LUNCH

One egg.

MIDDAY LUNCH

Meat broth, one cup; followed in one hour by
Soup, one small portion.
Lean meat, 159 grams.
Potatoes, 100 grams.
Fruit, 100 grams, without sugar.

AFTERNOON LUNCHES

3 P.M. Cup black coffee.
4 P.M. Fruit, 200 grams.
6 P.M. Milk, ¼ liter.

DINNER, 8 P.M.

Meat, 125 grams of cold meat, or 180 grams meat grilled.
Bread, 30 grams, graham.
Fruit, small portion as sauce without sugar.
Salad, vegetable or fruit, or radishes or pickles.

Summarizing this menu, we find that there is a total of:

Lean meat, 400 grams during the day, which would yield of dry proteins about 76 grams and of fat probably not less than 50 grams, though it might be possible, by carefully cutting away every vestige of fat, to reduce this to 30 grams.

Bread, 55 grams, in which there would be about 4.4 grams of protein, a vestige of fat and 28 grams of carbohydrates.

Potatoes, 100 grams, in which there would be 2 grams of protein, hardly more than a trace of fat, and 30 grams of carbohydrates.

Milk, about 250 grams, in which there would be about 8.3 grams of protein, 10 grams of fat, and 7.5 grams of carbohydrates. One egg, estimated weight at 50 grams, would represent 6.5 grams of protein, 4.6 grams of fat.

Fruit, between 300 and 400 grams; if we take apples, there will be not over 2 grams of proteins and not over 40 grams of sugar.

Footing up these values, we find that there will be a little less than 100 grams of protein, a little more than 100 grams of carbohydrates, and about 65 grams of fat. Assuming the menu to represent 200 grams of combined carbohydrates and protein, that would give us (counting 4 calories per gram) 800 calories for the proteins and carbohydrates, while 65 grams of fat would yield about 600 calories, making a total of *approximately 1,400 calories for the Van Noorden dietary.*

Discussing this dietary, the reader will be impressed with the fact that it is evidently a hospital dietary. The almost continuous serving of broths and soups would be altogether impracticable for everyday use in the home. Most of the cases of obesity that the physician has to deal with are in people who are obliged to continue their daily activities. The amount of food allowed by Van Noorden is, without doubt, a sufficient one, and the general principles illustrated in Van Noorden's dietary are unquestionably sound. These principles are, first, *the elimination of sugar*, so far as it is possible to do so; second, *the reduction of proteins to the physiological minimum;* third, *a moderate reduction only of the fats;* fourth, the production of a feeling of comfortable satiety by the free use of liquids, such as meat broths, tea, and water, which contain a comparatively small amount of nourishment as compared to their bulk.

Applying these principles of Van Noorden's, the author would suggest the following modification as more practicable for use in the ordinary cases that come into the physician's practice:

In choosing our proteins we will be governed by the findings of Professor Chittenden, as set forth in his work entitled, "Economy in Nutrition," and reduce the proteins to the physiological limit as we now understand it. The following menu may serve as suggestive:

BREAKFAST

One cup hot water.
One egg, boiled or poached.
One slice toast.
One-half grape fruit, or one orange.

LUNCH

Soup, ample bowl vegetable.

100 grams of meat (beef, mutton, veal, pork, fowl, game, or fish).

1 slice bread.

Fruit, choice of 1 apple, 1 orange, 1 bunch grapes, or a small portion of berries, or other fruit in season.

DINNER

1 cup bouillon.

Meat, 150 grams.

Potatoes, 100 grams.

Vegetables, 100 grams (spinach, cabbage, cauliflower, celery, radishes or lettuce).

Fruit, 1 apple, pear, peach, orange, half grape fruit, or other acid fruit.

If the patient will observe the following precautions—namely, eat very slowly, pulverize every morsel of food to an impalpable, creamy condition, until it gradually disappears from the mouth—he will find his hunger completely satisfied on these very limited rations. Until he gets used to this meager diet he is destined to feel a little empty at times. However, he will soon get adapted to the régime and his dilated stomach will shrink down to a condition in which it will feel comfortably full on the rations above outlined.

Combining this light ration with vigorous out-of-door exercise, such as golf, lawn tennis, rowing, horseback riding, or walking three or four miles each day to and from business, will in a very short time be followed by a substantial reduction in weight. This will continue until the subject has been reduced to normal proportions, unless there are some pathological conditions present that are out of the ordinary. One general rule that must be absolutely enforced if any progress is to be made in the reduction of weight is, *that all alcoholic beverages must be prohibited absolutely,* for reasons clearly set forth in a preceding chapter.

B. DIABETES

The most common form of this disease is called diabetes mellitus, so called because the urine contains sugar, but not all cases

of sugar in the urine or glycosuria should be classified as diabetes, because an excessive ingestion of carbohydrates, particularly of sugar, is likely to be followed by the appearance of sugar in the urine. This form of glycosuria is called alimentary glycosuria, and will disappear as soon as the diet returns to the normal, to reappear only when there is a repetition of the excessive use of carbohydrates in the diet.

But diabetes is a serious and incurable disturbance of the nutrition, consisting in an inability of the system to utilize sugar. As set forth in preceding chapters, all carbohydrates are reduced to monosaccharid conditions before they are absorbed. In this condition they circulate in the blood, passing to the liver through the portal vein. In the liver they are deposited in the form of glycogen, thus retiring them temporarily from the circulation. Experiment has shown that this general process of the utilization of carbohydrates in the body is largely controlled by an internal secretion from the pancreas. Experimental interference with the pancreas will interrupt or interfere with the oxidation of sugar in the body and cause it to appear in the urine. It is, therefore, believed that diabetes mellitus has for its principal cause or associated condition a disturbance of the action of the pancreas. While the glycosuria is the principal symptom, it is not the principal matter of importance. This place must be accorded to the general condition of the body—a moderate amount of sugar in the urine being of secondary importance if the general condition is good. Diabetes has been subdivided, on the basis of its severity, into mild, moderate, and severe.

The mild cases of diabetes are those in which the amount of sugar excreted is moderate in quantity and readily held under control through control of the diet. The severe forms of diabetes are those which cannot be completely controlled, even through the most rigid control of the diet. This latter form of diabetes is observed chiefly in the young. The reason for this is evident; it being an incurable disease, when it appears in the young it causes early death. When diabetes appears in those past middle age it is likely to be of the milder type.

In the treatment of diabetes it is important to accomplish the following things:

First: *To maintain the general nutrition;* the best index to this is the weight of the body. So long as the body weight is maintained, or, in the case of the young, the normal growth maintained, the attendants may feel assured that the general nutrition is being properly maintained.

Second: *To increase the power of the body to oxidize sugar.* Experiment and clinical observation have shown that, if the carbohydrates are wholly withdrawn from the diet for a time, the sugar-oxidizing function will seem to regain its power during the rest. A judicious return two or three times a year to a carbohydrate free diet seems to have the effect of strengthening the sugar-oxidizing function rather than weakening it.

Third: Every precaution must be taken *to avoid complications.* The most serious complication that is likely to arise as a result of the change in diet is a condition called acidosis, characterized by the presence of acid in the blood. The appearance of such acids as acetic acid is, under normal conditions, controlled, or at least their rapid oxidation assisted by the presence of carbohydrates and carbohydrate oxidation. When these are removed from the diet, there is danger of the accumulation of acids in the blood followed by serious symptoms involving the nervous system.

The following are some of the difficulties that the dietitian must seek to overcome in his choice of the dietary for these cases: First, the difficulty of arranging a diet which represents a sufficient number of calories when the carbohydrates are wholly or largely omitted. The average individual requires about 50 calories per kilo body weight when engaged in average work, while an individual of the same average weight would require about 30 calories per kilo weight when resting. Thirty calories per kilo would mean 1,800 calories for a person weighing 132 pounds. To get 1,800 calories of energy from a carbohydrate free diet demands such a large amount of various meats, cheese, fat, eggs, and other rich diet that the patient is very likely to become so tired of these nitrogenous and fatty foods that it is difficult to prepare a menu which will be accepted with relish and appetite. Another difficulty which the dietitian experiences is the almost inordinate craving on the part of the patient for carbohydrates. In normal

conditions of the nutrition the craving of the patient may be interpreted as a natural index to the character of food required, but in this case the natural craving is in the opposite direction. It is, of course, true that the system needs carbohydrates, but it is unable to use them. Their presence would only tax the digestive powers, and by the presence of excessive sugar in the blood serve to disturb the general nutrition, so that it becomes a clinical necessity to avoid any such excess. This craving may become so intense that the patient will actually attempt to get these forbidden foods and necessitate some watchfulness and care on the part of the attendants to make certain that the physician's orders regarding diet shall be followed. A further difficulty to overcome is the positive distaste for one of those foods which clinical experience shows to be an absolute necessity—namely, fat. In order to get enough nutriment it is necessary for the patient to eat large quantities of fat, but many patients have difficulty in eating any fat. Certain forms of fat are less distasteful than others and should be resorted to for most of the fat food. For example, butter and cream are generally liked and can be made the source of an important portion of the fats. Breakfast bacon, nicely browned, is relished by most people and can be utilized very largely in the diet. Egg yolk contains a large amount of fat and can be freely used. Nuts, also, particularly the butter nut, the black walnut, and the Brazil nut, contain a very large proportion of fat, and these may be freely used. By using skill and ingenuity in the choice of such foods as are rich in fat and proteins, and in the preparation of them in forms and varieties that tempt the patient's appetite, it is possible to meet all the requirements of any but the more serious cases that are really moribund from the first.

Finally, another difficulty that the dietitian always meets in diabetes is the tendency to constipation. It is a matter, however, of the greatest importance that the bowels be so regulated as to produce an evacuation each twenty-four hours.

Figs and prunes, mentioned above as effective in the control of constipation, are contraindicated in diabetes because of the large percentage of sugar which they contain. Recourse must, therefore, be had to another laxative food free from sugar. Rhu-

barb fills this requirement. Its intense acidity, however, will make it necessary to sweeten it, otherwise the patient may be unable to take it. Saccharin, which possesses a sweetening power about 300 times as intense as sugar, may be utilized in the place of sugar wherever it is desired to sweeten the food. Not over one and a half grains or one tenth of a gram should be used per day.

In arranging a course of diet for a diabetic case, the first thing to determine is the tolerance of the patient for carbohydrates. In order to make this determination it is necessary to reduce the patient to a diet absolutely free from carbohydrates for a period of about a week. In passing, it must be noted and emphasized that whenever recourse is had to a carbohydrate free diet, the transition from the usual diet to the diet free from carbohydrates should be a gradual one and should cover not less than a week's time. Begin the withdrawal of carbohydrates by a withdrawal of all sugars, as the cane sugar used in sweetening the fruits, cereals, etc. A day or two later drop out from the diet all fruits and vegetables which are rich in sugar. Follow this a couple of days later by dropping from the diet all vegetables and cereal products (except bread and potato) that contain starch. Finally, on the first day of the week in which the patient shall be on carbohydrate-free diet, cut out even the bread and potato. Van Noorden has devised a standard carbohydrate-free diet which has been very widely used, both in Europe and this country. This standard diet. as quoted from Osler, is as follows:

BREAKFAST

Tea or coffee, 6 ounces.
Lean meat (beefsteak, mutton chop, or ham), 4 ounces.
Eggs one or two.

LUNCH

Cold roast beef, 6 ounces.
Celery, or cucumbers, or tomatoes with salad dressing.
Coffee, without milk or sugar, 2 ounces.
Whisky, 5 drams diluted with 13 ounces of water.

DINNER

Bouillon, 6 ounces.
Roast beef, 7½ ounces.
Butter, 2½ drams.
Green salad, 2 ounces.
Vinegar, 2½ drams.
Olive oil, 5 drams, or spinach with mayonnaise, large portion.
Whisky, 5 drams diluted with 13 ounces water.

SUPPER, 9 P.M.

Two eggs, raw or cooked.

In mild cases there will be a rapid diminution of sugar from the urine until it has completely disappeared. In severe cases there will still be a small amount of sugar, even after a week or two of this diet. After a week of the minimum appearance of sugar in the urine, which minimum, as stated above, should be only a trace, it is customary to begin to add starch to the diet. Sugar is kept strictly out of the diet, except such minute quantities as gain access through certain fruits and green vegetables. The first starch-containing foods reinstated in the diet are the last ones removed in preparing the patient for the carbohydrate-free diet—namely, bread and potato. A reasonable menu for a diabetic case would be the following:

BREAKFAST.

Tea or coffee, 6 ounces.
Cream, 2 ounces.
Meat (beefsteak, mutton chops, or ham), 4 ounces.
Bread and butter, 2 slices.
Baked potato, with butter.

LUNCH

Cold roast beef or cold boiled ham, 6 ounces.
Bread and butter, two slices.
Salad with mayonnaise dressing, egg garniture.
Tea or coffee with cream.

4 P.M.

Egg lemonade or egg orangeade.

DINNER

Clear soup of any kind.
Roast beef or mutton, or pork.
Potatoes, baked or boiled.
Olives, celery, or radishes.
Side dish of green vegetables.
Bread and butter.
Dessert, milk-egg custard sweetened with saccharin.

The reader will notice that no alcohol is introduced into this diet. Many prominent clinicians advise the use of alcohol in moderate quantities in this disease. Clinicians who do not use it in any other disease use it in diabetes because it seems to assist the patient in the digestion and absorption of the fats in such a diet, as these are given in considerable quantities. When alcohol is used it is best to use it in the form of whisky or brandy rather than in any of the light wines or beers. The sweet wines and beers contain dextrin or sugar, or both, while the sour wines contain acids which disturb the digestion. Experience shows that if alcohol is to be used at all it should be in the form of diluted brandy or whisky. While there can be no objection to the use of alcohol in the case of an elderly person who has been used to it, the advisability of introducing it with freedom into the dietary of young people not addicted to its use, and particularly in the milder cases, is strongly to be questioned. Fortunately the milder cases can partake rather freely of bread and potato and reduce the fats of their dietary to a quantity which can easily be taken by most people, particularly if presented to them in the form of butter, cream, and other generally relished fats.

Many attempts have been made to devise breads that contain as little starch as possible. And so gluten bread and various other similar foods have been devised, but experience shows that these patent substitutes for common wheat bread have no especial advantage and certainly have marked disadvantages in comparison with the common breads. The practice has, therefore, come to be: *to revert to the use of common wheat bread and potatoes* as a source of the small amount of carbohydrates that may be admitted into the diet, the carbohydrates in bread and potatoes being a

form of starch which is much better borne than other carbohydrates. Furthermore, the substitutes for bread and potatoes, as, for example, the gluten bread, bran bread, Soya biscuits, almond cakes, etc., are usually very distasteful to the patient, and for that reason alone are contraindicated.

Van Noorden has given four tables of foods which are important to the dietitian in arranging the diet of a diabetic. The first group contains a list of those foods that are "unconditionally allowable." These foods always in order for diabetic cases are as follows:

Group I.—Fresh meat and preserved meat, including fish, oysters, clams, lobsters, and turtle. Meat extracts, eggs, fats, fresh vegetables which are poor in sugar and starch; pickles of all kinds; clear soups of all kinds; cheese of all kinds; coffee, tea, without sugar, with or without cream; fruit-acid drinks; natural or artificial carbonated waters; light wines, when prescribed by the physician.

Group II.—In this group are named foods which contain a small amount of carbohydrates, but not sufficient to seriously complicate the dietary. Two, three, or four of these foods can be introduced daily on the advice of the physician, but the portion served should not exceed that indicated in the list: Calves' liver, 100 grams; cream, 4 to 6 tablespoonfuls a day; cocoa, prepared without sugar, 1 ounce; cheese, 1 or 2 ounces; vegetables, such as turnip, cabbage, pumpkin (2 tablespoonfuls); green peas, string beans, carrots, Brussels sprouts (1 tablespoonful); radishes, celery, tomatoes, nuts (2 walnuts or 6 hazel nuts, 3 almonds or 8 Brazil nuts). Fresh fruits, thin slice of melon, small tart apple, peach, one small portion raspberries, strawberries, currants, greengages, or cherries.

Group III.—In this group the proportion of carbohydrate is so great that it is necessary to decrease the bread when these are introduced. The portions here indicated are the equivalent of 50 grams (nearly 2 ounces) of white bread, so that the introduction of the proportions here given to the dietary of one day should be accompanied by a subtraction of 50 grams of white bread from the dietary of that day:

1 quart of milk, sweet or sour.
1 quart buttermilk.
2 to 3 pints of koumiss or kefer.
1 quart cream.
2 ounces rye bread or graham bread.
1 ounce zwieback.
1 ounce sugar.
1 ounce sweet preserves.
1⅔ ounces fruit jam.
1⅓ ounces honey.
1⅓ ounces cereal, flour, or meal.
1½ ounces bean, pea, or lentil flour.
1 ounce starch, as cornstarch, rice flour, tapioca, sago.
1 ounce farinaceous preparations, as macaroni, oatmeal, barley, grits, noodles.
1⅔ ounces dry beans, peas, or lentils.
3 ounces green peas.
6 ounces new potatoes.
4⅔ ounces winter potatoes.
4 ounces apples, pears, plums, apricots, cherries, or grapes.
6 ounces strawberries, raspberries, gooseberries, mulberries, currants, blackberries, whortleberries, blueberries.
1⅓ ounces figs.
3 peaches or bananas.
Handful of walnuts, hazel nuts, or Brazil nuts.

Group IV.—This group contains a list of foods which are of special value because of the large proportion of proteins and fat and the very small proportion or complete absence of carbohydrates.

100 Gm. [A Trifle Over Three Ounces.]	Protein.	Fat.	Carbohydrates.	Calory Value.
Vegetable oil	1	100		930
Butter	1	85	0.5	830
Bacon (salt or smoked)	10	76		748
Devonshire cream	2	57	0.2	538
Cream cheese (Gervais, Neufchâtel, Stilton, Stracchino, etc.)	19	41	0.1	451
German sausage (Cervelatwurst)	18	40		456
Ham	25	36		437
Cheddar cheese	28	33	0.2	422

18

100 Gm. [A Trifle Over Three Ounces.]	Protein.	Fat.	Carbohydrates.	Calory Value.
Fat pork	14	37		400
Smoked ox-tongue	24	32		396
Fatty cheese (average)	25	30	1.5	381
Yolk of egg	16	31	0.5	354
Fat goose	16	30		345
Fat beef and mutton	17	29		337
Brie cheese	19	26	.1	320
Fresh-water eel	13	28		312
Smoked mackerel	19	22		382
Caviare	31	16		276
Cream	4	23	4	230
Fat salmon (fresh or smoked)	22	13		210
Hens' eggs (weighed with the shells) (2 large)	12	10	0.5	142

C. GOUT

This is a disease of luxury and intemperance. It is likely to visit people, especially men of past middle age who have for many years indulged in heavy foods, such as rich pastries and puddings, meat three times a day at least, and in large quantities. They have usually indulged in a free use of alcoholic beverages.

The disease is characterized by excruciating pains of the joints of the feet, especially the metatarso-phalangeal, supposed to be caused by deposit there of uric acid and other waste materials. Whether or not this theory of the cause of the disease is correct, the dietetic treatment appropriate for the condition must be clearly evident. In the first place, the gouty patient who would have any respite from his condition must be willing to make a complete reversal of his eating and drinking habits. He should change to *a low protein diet,* abstemious as well in the quantity of fats and carbohydrates; absolutely all use of alcohol must be suspended, preferably stopped indefinitely. As these patients have usually been very inactive, a change must be introduced in this field of the hygiene as well, and he must begin regular daily exercise in the open air for several hours if possible. This may begin with very light exercise, such as driving, followed by horseback riding, and this in turn by cross-country walks and golf. The influence of baths and of a free use of various mineral waters should not be forgotten in the treatment of this condition.

D. SCURVY

While gout is a disease of luxury, scurvy is a disease of privation. This privation may be caused by penury or it may be caused by isolation. Sailors and soldiers isolated from markets and gardens, and where they cannot obtain fresh fruits and vegetables, are most subject to this scourge. While the pathology of the condition is not thoroughly understood, the cause is generally accepted to be as above indicated. The rational treatment for the condition is a free use of fresh vegetables and fruits, also fresh meats in place of smoked, pickled, and canned meats. When this can be accomplished there is usually a gradual return to the normal condition.

CHAPTER XVIII

DISEASES OF ORGANS OF EXCRETION, CIRCULATION, RESPIRATION, AND OF THE SKIN

A. DISEASES OF THE KIDNEYS

1. Acute Nephritis.—This disease is characterized by the appearance of albumin and casts in the urine. The loss of this albumin from the blood leads to a disturbance of nutrition.

Whenever organs become diseased, the rational treatment always provides a rest more or less complete for the diseased organ. Naturally, this rest cannot be absolute in the case of some organs, and cannot be long extended in the case of any organ, because the function of no organ can be long dispensed with, if at all. However, the rational treatment is to lighten the work of the organ as much as possible and for as long a period as possible, after considering the general body conditions.

The work of the kidneys, as set forth in an earlier chapter, is to excrete the various soluble salts and end products of nitrogenous excretion—all these dissolved in water. The work of the kidneys seems to be facilitated when there is an ample supply of water in the body fluids. In many cases the excretion of water is not interfered with by the inflammatory processes in the kidneys. When such is the case water should be used very freely, as it facilitates the excretion of the nitrogenous products. If the water is not properly excreted by the kidneys, there will be no increase in the volume of urine and there will be a beginning edema of the loose, cellular tissues. When these symptoms are present the water must be reduced to two or three pints per day.

As uric acid and the other related bodies are formed from nucleins, it is best to exclude these from the diet as much as possible.

To that end, abstain from all dishes made from the glands of animals, such, for example, as liver, sweetbreads, kidneys, also brains. Any benzoic acid in the food is changed to hippuric acid and excreted by the uriniferous tubules. To relieve these tubules of the necessity of this work, abstain from green vegetables, stone fruit, and cranberries, all of which contain benzoic acid. Potassium salts should also be taken as sparingly as possible to that end; potatoes should be reduced to a very low limit.

A matter of the first importance is to follow throughout the course of the disease *a low protein diet.* As set forth above, this low protein diet is ample for the necessities of the body, while it relieves the kidneys of a very considerable portion of their work. To this end, never permit more than sixty grams per day (two ounces) of the protein, as shown in the table of chemical composition. In the early stages of acute nephritis the diet should be a liquid one of milk and cream mixed, two parts of milk to one of cream, and should not exceed three pints a day for the first few days. If the urine is very scanty, this may be reduced to one and one half pints, taken in four or five installments. After this initial period covering three to six or seven days, a gradual recourse may be had to carbohydrates and fats, as bread, rice, bacon, butter, all in very small amounts, continuing the milk and cream as the basis of the diet. As the patient convalesces, a general mixed diet in gradually increasing amounts can be presented.

2. **Chronic nephritis,** either parenchymatous or interstitial, should be treated dietetically in a way similar to the convalescing patient recovering from acute nephritis. In the occasional acute exacerbations, follow the diet outlined for acute nephritis above. To be strictly prohibited in all cases of nephritis are alcoholic beverages, pastries, puddings, spices, and condiments, including salt.

3. **Renal Calculi.**—The presence of renal calculi is manifested by a renal colic, in which the calculi are passing from the kidney to the bladder. During this time the patient experiences excruciating pain and no food will be taken. Once a calculus is formed, nothing in a dietetic way can be done to dissolve it or to facilitate its removal. A modification of the diet may, however, have a prophylactic action and thus be important to observe. The best prophylaxis is the use of large quantities of pure water, as this

holds salts in solution and hinders their deposit in the form of calculi. One should also avoid the use of tomatoes, because of the oxalic acid which they contain. Furthermore, there should be abstinence from all alcoholic beverages.

B. DISEASES OF THE CIRCULATORY SYSTEM

1. **Chronic Valvular Disease of the Heart.**—This condition of the heart leads to a disturbance of the work of the kidneys, because of a change of the volume of blood flowing through them and of the blood pressure. For similar reasons it disturbs the action of the lungs and sometimes even of the digestive organs. The dietetic watchword should be *abstemiousness,* beginning with low protein and using a considerable amount of milk or milk and cream as a staple article of diet, adding such other easily digestible and nourishing cereals, meats, fruits, and vegetables as will make up a moderate diet. Whenever there is a dilatation of the heart as a complication of the condition, the volume of water imbibed should be reduced to a minimum.

2. **Arterial Sclerosis.**—This diseased condition of the arteries is due to immoderation: immoderate eating, immoderate working, immoderate drinking. It is a disease following excesses, and is therefore likely to be associated with gout. The treatment should be the same as outlined above under Chronic Nephritis. The principal thing to be observed in the dietetic change is low proteins.

3. **Angina Pectoris and Aortic Aneurysm.**—For these conditions no specific diet has been devised; the general rule of a low protein diet, moderate in quantity and made up of simple, easily digestible foods, seems to be best adapted to the condition.

C. DISEASES OF THE RESPIRATORY ORGANS

1. **Acute Infections.**—Acute infections, such as *acute bronchitis, broncho-pneumonia, lobar pneumonia,* and *pleurisy,* are treated as acute infectious diseases outlined in a preceding chapter.

2. **Chronic Diseases.**—Tuberculosis, see Infectious Diseases.

Chronic Bronchitis: Patients suffering from this disease should have a diet similar to that presented in the case of chronic valvular disease of the heart.

3. **Asthma.**—In this disease the principal precaution to observe is to avoid a heavy meal at night. It is therefore important to have the dinner in the middle of the day, followed by a very light supper of easily digestible foods. Hot drinks may be used with the supper and may be taken just before retiring. It is important to avoid constipation. The diet should be so chosen as to insure one free normal passage each day.

D. DISEASES OF THE SKIN

A more or less direct relation between the diet and skin conditions is not infrequently observed. It is therefore a matter of some importance to regulate the diet in many, if not most, cases of skin diseases.

1. **Acne.**—In both the acne vulgaris and acne rosacea the diet should be simple and light. The patient should avoid condiments, pastries, rich puddings, and sweets.

2. **Erythema nodosum** is associated usually with gout, rheumatism, or malaria, and, being only an accompanying symptom of those diseases, should have no special diet other than the diet prescribed for the disease which it accompanies.

3. **Psoriasis.**—In this disease there seems to be no special relation between the diet and the skin condition. It is customary, therefore, to prescribe for the patient a diet indicated by his general condition. If he is corpulent, use the diet fitted to reduce adipose. If he is constipated, use a diet directed to the correction of that symptom, and so on.

4. **Purpura.**—As this disease has apparently been caused, in certain cases, by the use of asparagus, this vegetable should be excluded from the diet; otherwise a light mixed diet may be used.

5. **Urticaria** (*Hives*).—Between this condition and the food there seems to be a more or less intimate relation. Some people are unable to eat even a small portion of some particular vegetable or fruit, as, for example, strawberry or banana, without being

afflicted with an aggravated case of urticaria. This is to be considered an idiosyncrasy. Food that is poison to one person may be not only pleasing, but altogether wholesome and advantageous to another. Such food idiosyncrasies are certain to be discovered early in life. After it has been discovered that some particular food causes any serious disturbance, whether urticarial or otherwise, the rational procedure is to omit that food from the dietary. This omission of foods which precipitate attacks of urticaria is the only dietetic precaution to be observed.

6. **Xanthoma diabeticorum.**—As the name suggests, this skin affection being an accompaniment of the diabetic condition, the diet must naturally be that described above for the systemic condition of diabetes.

APPENDICES

APPENDIX I

A. CLASSIFICATION OF DIETS

I. BEVERAGES

1. **Water.**—Pure and carbonated; mineral waters, containing iron, sulphur, lithium, etc.

2. **Fruit Juices.**—Grape juice, apple juice, pineapple juice, orangeade, lemonade.

3. **Carbonated Bottled Drinks.**—Fruit sodas, any flavor, in siphon bottles; root beer, ginger ale, etc.

4. **Stimulants.**—Coffee, black, or with milk or cream, with or without sugar, hot or iced.

Tea, with or without milk or cream or sugar, hot or iced.

Cocoa and chocolate.

5. **Alcoholics.**—As classified above (Chapter XIV).

6. **Farinaceous Beverages.**—Toast water, rice water, oatmeal water, barley water, and cereal coffee.

II. LIQUID FOODS

1. **Milk.**—Whole or skimmed; peptonized; boiled; sterilized; pasteurized; milk with limewater, Vichy, Apollinaris, etc. Milk with equal parts of farinaceous liquids; albuminized milk, with white of egg. Milk with egg yolk, flavored with vanilla, cinnamon, or nutmeg. Milk flavored with coffee, cocoa, or meat broth. Milk punch, milk lemonade, koumiss, kefir, whey with lemon juice, champagne, or wine.

2. **Egg Preparations.**—Albumin water (diluted egg white), flavored with fruit juice; egg lemonade, egg orangeade; egg with meat broth; egg with coffee and milk, or chocolate egg-nog.

3. **Meat Preparations.**—Meat juice, from beef or mutton; beef or mutton tea; broth from beef, mutton, veal, chicken, oyster, clam. Meat soups, bouillon, beef extract.

4. **Soups.**—*Clear.*—Bouillon, consommé, vegetable soup, Julienne, with thickening; barley, rice, chopped vegetables, chopped meat, egg.

Cream Soups.—Celery, onion, potato, corn, carrot, pea, bean, tomato, rice, asparagus.

Purées.—Potato, turnip, chestnut, carrot, bean, pea, asparagus, chicken, rice, vegetable.

III. SEMI-SOLID FOODS

1. **Jellies.**
   - (*a*) Meat jellies and gelatin; veal, beef, chicken, mutton.
   - (*b*) Starch jellies (fruit-flavored); cornstarch, arrowroot, sago, tapioca.
   - (*c*) Fruit jellies and gelatin.
2. **Custards.**
   - (*a*) Junkets, milk or milk and egg (rennet curdled), flavored with vanilla, nutmeg, etc.
   - (*b*) Egg-milk custard, boiled or baked, and variously flavored.
   - (*c*) Cornstarch, tapioca, and boiled custard.
   - (*d*) Frozen custard (New York ice cream).
3. **Gruels** (Farinaceous).
   - (*a*) Milk gruels.
   - (*b*) Water gruels.
4. **Toasts.**
   - (*a*) Cream toast.
   - (*b*) Milk toast.
   - (*c*) Water toast.
5. **Creams.**
   - (*a*) Plain.
   - (*b*) Whipped.
   - (*c*) Ice cream.

6. Oils.

(*a*) Plain olive, cotton seed, or nut.
(*b*) Butter.
(*c*) Emulsion, as mayonnaise.
(*d*) Cod-liver oil, plain or emulsified.

7. Soufflés of Fruit.

IV. SOLID FOODS

(*Suitable for Invalids*)

1. Cereals.

(*a*) Porridges and mushes—Oatmeal, corn meal, wheat, rice, etc.
(*b*) Dry preparations—Shredded wheat biscuit, corn flakes, etc. Puffed rice, puffed wheat.

2. Breads.

(*a*) *Plain.*—White, graham, whole wheat, brown, rye, etc.
(*b*) *Toasts.*—Dry, buttered, zwieback.
(*c*) *Crackers.*—Soda, graham, oatmeal, Boston butter, milk.
(*d*) *Biscuits.*—Yeast biscuit, baking-powder biscuit, beaten biscuit.

3. Egg Preparations.

(*a*) Boiled, poached, scrambled, shirred.
(*b*) Omelets.
(*c*) Soufflés of meat and of potatoes.

4. Meats.

(*a*) Beef or mutton—Broiled or roasted.
(*b*) Chicken, turkey, or game—Broiled, roasted, etc.
(*c*) Fish—Boiled, broiled, or baked.
(*d*) Oysters—Panned, stewed, etc.
(*e*) Clams—Chowder, broth with clams, baked.

5. **Vegetables.**

   (*a*) Potatoes—Baked, boiled, creamed, and escalloped.
   (*b*) Sweet potatoes, baked and boiled.
   (*c*) Green peas, plain and creamed.
   (*d*) Lima beans, plain and creamed; string beans, plain and creamed; cauliflower, plain and creamed; carrots, parsnips.

6. **Fruits.**

   (*a*) Fresh—Oranges, bananas, grapes, melons, etc.
   (*b*) "Sauces" or stewed—Apples, plums, apricots, pears, berries, etc.
   (*c*) Baked—Apples, bananas, pears.
   (*d*) Canned—Peaches, apricots, plums, pears.
   (*e*) Preserved—Peaches, plums.

B. RECIPES

BEVERAGES

It is proposed here to give a brief treatment of those foods that are not usually given in household books of recipes. Every dietitian will, of course, have in his possession and be familiar with the usual recipes for all the foods in general use in the home and in institutions.

The author will give here general recipes only.

With the aid of these general recipes any skillful attendant will be able to prepare any of the special invalid foods here listed, and many more.

Farinaceous Beverages.—Farinaceous beverages (toast water excepted) are all made by slowly adding cereals, such as barley, rice, oatmeal, etc., to a large quantity of boiling water and cooking it for two or three hours. Strain off the liquid and season it to taste.

Toast Water.—Toast bread until it is hard and black with carbon. Pour boiling water over it. Let it stand for an hour. Strain and use the liquid.

LIQUID FOODS

Meat Juice.—Meat juice is always undiluted, and may be extracted in three ways:

(1) Broil quickly or even scorch small pieces of beef. Squeeze out the juice with a lemon squeezer, previously dipped into boiling water. Catch the juice in a hot cup. Season and serve. To heat, place the cup in hot water (below 160° F.).

(2) Broil quickly and put the small pieces into a glass jar. Set the covered jar in a pan of cold water. Heat gradually for an hour, never allowing the heat to exceed 160° F. Strain and press out the clear, red liquid. Season and serve. One pound of beef yields eight tablespoonfuls of juice.

(3) Grind raw beef in a meat grinder. Place in a jar with a light cover and add one gill of cold water to a pound of beef. Stand it on ice overnight. Strain and squeeze through a bag. Season and serve.

Meat Tea.—Meat tea is made in the proportion of a pound of meat to a pint of water. Grind the meat in the meat grinder. Place in a jar and cover with the cold water. Set the jar in an open kettle of water and cook for two hours or more, not allowing the temperature to exceed 160° F. Strain, squeeze through a bag, skim off fat, season, and serve.

Meat Broth.—Meat broth is made from meat and bone, with or without vegetable. The proportion is a quart of water to a pound of meat. Cut the meat into small pieces (dice), add the cold water, and simmer until the quantity is reduced one half. Strain, skim, and season with salt. Many different results may be obtained by varying the meat (chicken, veal, mutton, beef, etc.), and the seasoning (onion, celery, bay-leaves, cloves, carrots, parsley, etc.). The nutriment may be increased by the addition of rice, barley, tapioca, or stale bread crumbs.

Clams and Oysters.—Cut up fine. Cook in their own liquor and an equal quantity of water. Bring to a boil and simmer for five minutes. Strain and season. Milk may be used with the water, or instead of the water.

Soups.—*Clear Soups.*—Clear soups are made by cooking raw meat or vegetables, or both together, slowly for a long time, strain-

ing and using the liquid. The vegetables and meat, or either, may be added while raw, or an entirely different flavor may be obtained by browning the meat or vegetables in butter before adding the water.

Cream Soups.—Cream soups are made in the proportion of one quart of vegetables (such as corn, peas, beans, or tomatoes, a bunch of celery or asparagus) to one pint of water and a pint of milk. Cook the vegetables thoroughly in water and mash through a colander. To this water and pulp add a cream sauce made in the proportion of four tablespoons flour, four tablespoons butter, and a pint of milk for vegetables poor in starch or protein, and two tablespoons flour, two tablespoons butter, and a pint of milk for those rich in starch and protein. Season to taste. Tomato acid should be counteracted by the addition of one eighth tablespoon of soda before the milk is added. Potato soup should be flavored with onion or celery, or both.

Purées.—Cook the vegetables thoroughly. Press through a colander and add enough water or milk to make a porridge-like consistency. Butter and other seasoning may be added to taste.

SEMI-SOLID FOODS

Jellies.—*Meat Jellies.*—Meat jellies are made in two ways:

(1) Cook soup meat (containing gristle and bone) slowly for a long time in just enough water to cover. Strain and set the liquid away in a mold to cool and set. If desired, bits of shredded meat may be added to the liquid before molding.

(2) Use meat broth and gelatin in the proportion of one tablespoon gelatin to three quarters of a cup of hot broth. Pour into mold and set on ice.

Starch Jellies.—Starch jellies are made by cooking in a pint of fruit juice or water until clear, two tablespoons of tapioca, arrowroot, sago, cornstarch, or flour. Sweeten to taste.

If water is used, fresh fruit may be used either in the jelly or in a sauce poured over the jelly.

Fruit Jellies.—These are made:

(1) Of fruit juice and sugar in equal quantities cooked until it will set when cooled;

(2) Of fruit juice and gelatin in the proportion of one tablespoon of gelatin to three fourths of a cup of fruit juice, or one half box gelatin to one and a half pints of juice. Sugar to taste. Made tea or coffee, or cocoa or lemonade may be used in the same proportion.

Custards.—These are made with (1) milk, (2) milk and eggs, (3) milk, egg, and some farinaceous substance as rice, cornstarch, tapioca. In the first the coagulum is produced by the addition of rennet, in the other two by the application of heat.

Plain Junket.—Dissolve in a cup of lukewarm milk (never warmer), a tablespoon of sugar or caramel syrup. Add a quarter of a junket tablet, previously dissolved in a tablespoon of cold water. Stir a few times, add vanilla, nuts, or nutmeg if desired. Pour into a cup and set aside to cool and solidify. This may be served plain or with whipped cream, or boiled custard.

Egg-milk Custard.—When eggs are used for thickening, not less than four eggs should be used to a quart of milk (more eggs make it richer).

Boiled Custard.—One pint of milk, two eggs, half cup of sugar, half saltspoon of salt. Scald the milk, add the salt and sugar, and stir until dissolved. Beat the eggs very thick and smooth. Pour the boiling milk on the eggs slowly, stirring all the time. Pour the mixture into a double boiler, set over the fire and stir for ten minutes. As soon as a thickening of the mixture is noticed remove from the fire, pour into a dish and set away to cool. Add flavoring. This custard makes *cup custard,* the sauce for such puddings as *snow pudding,* and when decorated with spoonfuls of beaten egg-white, makes *floating island.*

Baked Custard.—Proceed as in boiled custard, but instead of pouring into a double boiler pour into a baking dish. Set the dish in a pan of water, place in the oven and bake until the mixture is set in the middle.

Farinaceous Custards.—Make like boiled custard, using one less egg and adding one quarter cup of farina, tapioca, cornstarch, arrowroot, or cooked rice to the hot milk and egg.

Sago should be soaked overnight before using.

Tapioca should be soaked one hour before using.

Coffee Custard.—Scald one tablespoon of ground coffee in milk and strain before proceeding.

Chocolate Custard.—Add one square of grated chocolate to the milk.

Caramel Custard.—Melt the dry sugar until golden brown, add the hot milk, and when dissolved proceed as before. Bake.

Gruels.—Gruels are a mixture of grain or flour with either milk or water. They require long cooking and may be flavored with sugar, nutmeg, cinnamon, or almond.

Take the meal or flour (oatmeal, two tablespoons, or cornmeal, one tablespoon, or arrowroot, one and a half tablespoons). Sift it slowly into one and a half cups boiling water, simmer for an hour or two. Strain off the liquid; add to it one teaspoon of sugar, season with salt, and add one cup of warm milk.

Water Gruel.—If water gruel is desired, let the last cup of liquid added be water instead of milk.

Cream Gruel.—A cream gruel may be made by using rich cream instead of milk or water.

Barley Gruel.—Barley gruel (usually a water gruel) is prepared as follows: Moisten four tablespoons of barley flour in a little cold water and add it slowly to the boiling water. Stir and boil for twenty minutes.

Toasts.—*Cream Toast.*—Toast the bread slowly until brown on both sides. Butter and pour over each slice enough warm cream to moisten (the cream may be thickened slightly and the butter may be omitted).

Milk Toast.—One tablespoon of cornstarch or flour; one cup of milk, salt to taste, and boil. Butter the toast and pour over it the above white sauce.

Water Toast.—Pour over plain or buttered toast enough boiling water to thoroughly moisten it.

Soufflés of Fruit, Etc.—The distinguishing feature of a soufflé is a pasty or pulpy foundation mixture, and the addition of stiffly beaten egg-white. A soufflé may or may not be baked.

Plain Soufflé.—Two tablespoons flour; one cup of liquid (water, milk, or fruit juice); three or four eggs; sugar to suit the fruit. If thick fruit pulp is used, omit the thickening. Beat the egg

yolks until thick. Add sugar gradually and continue beating. Add the fruit (if lemon juice add some rind also). Fold in the well-beaten whites. Bake in a buttered dish (set in a pan of hot water) for thirty-five or forty minutes in a slow oven.

Fresh Fruit Soufflé.—Reduce the fruit to pulp. Strawberries, peaches, prunes, apples, bananas, etc., may be used. Sweeten the pulp. Beat the egg-white to a stiff froth, add the fruit pulp slowly. Chill and serve with whipped cream or soft custard.

Chocolate Soufflé.—Two tablespoons flour; two tablespoons butter; three quarters cup of milk; one third cup of sugar; two tablespoons hot water. Melt the butter, add the flour and stir well. Pour the milk in gradually and cook until well boiled. Add the melted chocolate, to which the sugar and hot water have been added. Beat in the yolks and fold in the whites of the eggs. Bake twenty-five minutes.

Farina Soufflé.—Cook the farina (four tablespoons) in a pint of boiling water. Stir this with the egg-yolks, add sugar or salt, and later fold in the egg-whites, flavor, and set away to cool.

SOLID FOODS

Egg Preparations.—*Soft-boiled Eggs.*—Into a quart of boiling water place two eggs. Cover the dish and allow them to remain six minutes.

Omelets.—Beat the yolks and whites separately. Fold the whites into the yolks. Have a tablespoon of butter boiling hot in a pan. Pour in the omelet and cook until brown. Fold double and serve hot. Allow one egg to a person.

Fancy Omelets.—Minced cooked meat; vegetables, nuts, or fruits may be put on the omelet while it is browning and be folded in.

Soufflés of Meat or Vegetables.—Make a white sauce (one tablespoon flour, one tablespoon butter, one cup of milk) as a foundation. Add a cup of cooked and chopped meat, fish, oysters, or vegetables, the beaten yolks and lastly fold in the beaten whites. Serve hot, with or without baking.

For any further recipes for the preparation of solid foods see any good book of household recipes.

APPENDIX II

Any adequate understanding of the chemistry of foods, the chemistry of cooking, and the chemistry of digestion and metabolism must be based upon chemical experimentation. Descriptions of these processes read from books are altogether inadequate.

With a view of furnishing a basis for this chemical experimentation the author presents herewith a brief chapter setting forth simple chemical experiments, first, on the foodstuffs, carbohydrates, proteins, and fats, then on the common food materials as these are found in the market, ending the chapter with a brief outline of experimental work on the processes of digestion.

A. EXPERIMENTAL CHEMISTRY OF FOODSTUFFS

I. THE CARBOHYDRATES

1. **Materials.**—Potato starch, dextrin, dextrose, maltose, lactose, saccharose, and cellulose (represented by absorbent cotton and ashless filter paper).

2. **Preparation.**—(1) *To Prepare Fehling's Solution.*—(*a*) Into a half liter, glass-stoppered bottle put 34.64 grams $CuSO_4$, c.p., and enough H_2O dist. to make 500 c.c. Label the solution: *Fehling's Solution* (*a*). (*b*) Into a similar receptacle put 173 grams of potassic-sodic tartrate (Rochelle salt), and 50 grams of NaOH, weighed in sticks; add enough water to make 500 c.c. Label: *Fehling's Solution* (*b*). For use, mix these solutions in equal parts. A convenient quantity for the following experiments is 100 c.c. of each solution.

(2) Prepare a starch paste by rubbing 1 gram of starch to a creamy consistence with water, add 50 c.c. of distilled water, and boil.

(3) Prepare a dilute solution of iodin by direct solution in water or by diluting an alcoholic solution.

3. **Experiments and Observations.**—(1) Put a little dry starch into an evaporating dish; add some dilute iodin. The starch turns blue. Pour a few drops of starch paste into a test-tube; add a few drops of iodin. Iodin may be used to detect the presence of raw or of cooked starch.

(2) Put some raw starch into a test-tube or beaker; add water and stir. The starch does not seem to be at all soluble in water. Stir or shake the mixture to bring the starch into suspension in the water; pour upon a filter. A clear filtrate passes readily through. Test the filtrate for starch; result, negative; pour a few drops of iodin upon the filter, starch present.

Conclusions:

(*a*) Potato starch is insoluble in cold water.

(*b*) The granules of potato starch will not pass through common filter paper.

(3) Dilute a few centimeters of starch paste; pour it upon a filter; to the filtrate add iodin. The blue color indicates that in the cooking of starch the grains are broken up into particles sufficiently small to pass readily through the meshes of common fiber paper.

(4) In order to determine whether dilute starch paste will, in response to the laws of osmosis, pass through an animal membrane, fill a dialyzer with dilute starch paste. Set aside to be tested one or two days later.

(5) Add water to dextrin in a beaker; stir with a rod. Dextrin is readily soluble in cold water. To a small portion add iodin. The solution will probably assume a wine-color; the typical reaction of erythrodextrin. The color fades presently.

(6) Fill a dialyzer with diluted dextrin solution and leave for subsequent examination. Test the next day to find if dextrin passes through.

(7) Add water to dextrose; it is readily soluble. Add iodin to a portion of the solution; result, negative.

(8) *Fehling's Test for a Reducing Sugar.*—To a few drops of the solution add several cubic centimeters of Fehling's solution and boil. A yellowish precipitate of cuprous oxid (CuO) ap-

pears. If the boiling is continued the color changes to a brick-dust red.

(9) To a solution of maltose add Fehling's solution and boil; the copper solution is reduced, and CuO is precipitated.

(10) To a solution of lactose add Fehling's solution and boil; reduction takes place.

(11) Subject a solution of saccharose to the Fehling test. No reduction occurs. Vary the test by boiling the solution with a few drops of dilute HCl before adding the Fehling solution. The acid splits the disaccharid cane sugar into its monosaccharid components, one of which reduces the Fehling solution.

(12) *Trommer's Test for a Reducing Sugar.*—To any liquid suspected of containing a reducing sugar, add a few drops of dilute $CuSO_4$ solution; to this mixture add an excess of NaOH (or KOH); boil; if the suspected liquid contains a reducing sugar the $CuSO_4$ will be reduced with precipitation of CuO. Subject all of the solutions of sugar in turn to the Trommer test. Note that the appearance is practically the same as with the Fehling test. Any differences are due only to a difference in the proportions of the two reagents. The Fehling test is the more satisfactory one.

(13) Fill a dialyzer with a dilute solution of dextrose for subsequent examination.

(14) Fill a dialyzer with a dilute solution of maltose or lactose for subsequent examination.

(15) Fill a dialyzer with a dilute solution of saccharose for subsequent examination.

(*a*) How may carbohydrates be classified? (I. monosaccharids, II. disaccharids, III. polysaccharids.)

(*b*) Which class has the lowest grade of hydrates?

(*c*) How many of this class are soluble in cold water?

(*d*) How many are diffusible?

(*e*) Which class has the highest grade of hydrates?

(*f*) Are all of those which belong to classes I. and II. soluble in water?

(*g*) Which are diffusible?

(*h*) How many of the carbohydrates reduce $CuSO_4$ in the presence of an excess of NaOH or KOH?

(*i*) How many of the carbohydrates are diffusible?

(*j*) How may one determine whether or not cane sugar passed through the animal membrane?

II. THE PROTEINS

1. **Materials.**—An egg, fibrin, gelatin, acid albumin, commercial peptone (mixed albumoses, proteoses, and peptones), Grubler's pure peptone.

(1) *To Prepare Dilute Egg Albumin.*—Make an opening in end of the shell of an egg; drain off the white of the egg, catching it upon a coarse linen cloth—a towel serves the purpose well; press the albumin through the meshes of the linen into a beaker; add 400 or 500 c.c. of distilled H_2O; transfer the mixture to a 1-liter cylinder, and shake vigorously; after a short time filter through pure absorbent cotton or strain through fine linen.

(2) *To Prepare Acid Albumin.*—To 100 c.c. of dilute egg albumin add an equal quantity of 0.2 per cent hydrochloric acid; place the mixture in the incubator for two or three hours. Though the change begins at once, it will probably not be complete before the time suggested. If one wishes to isolate the acid albumin from the mixture, he has only to neutralize carefully with sodic hydroxid, precipitating the acid albumin, and to wash the precipitate with distilled water. For the purpose for which it is to be used in the following demonstation, it may be left in the acid solution, which represents 0.1 per cent HCl. Label: *Acid Albumin Solution in 0.1 per cent HCl.*

(3) Make an aqueous solution of the commercial "peptone," and, though the peptone is present in small proportions, label: *Proteoses.*

(4) Make an aqueous solution of a few grams of Grubler's pure peptone, and label: *Peptone.*

(5) Dissolve a few grams of gelatin in distilled water.

2. **Experiments and Observations.**—(1) *The Heat Test.*—Pour into test-tubes a few cubic centimeters of each of the following protein solutions and subject each in turn to a temperature of 63° C. (145° F.), and, finally, to a temperature of 100° C. (212° F.), by dipping the tubes into water baths of the temperatures named;

(*a*) Dilute egg albumin.

(*b*) Acid albumin in acid solution.

(*c*) Gelatin in aqueous solution.

(*d*) Proteoses.

(*e*) Peptone.

Record results in a table and formulate conclusions.

(2) Subject the same series of proteins to the *Cold Nitric Acid Test* by pouring, first, 1 c.c. or 2 c.c. of strong nitric acid into a test-tube; then, with a fine-pointed pipette, carefully floating the protein liquid upon it. In the case of the dilute egg albumin, a characteristic white ring forms between the acid and the albumin. Note in each case whether or not a typical ring is formed.

Tabulate results and formulate conclusions in a concise statement.

(3) *The Xanthoproteic Test.*—Use the tubes and materials already prepared in the cold nitric-acid test. Shake the tubes to mix the acid with the protein. In some cases a coagulum will be formed, and this coagulum turns yellow on boiling, if the tube is held in a Bunsen flame. After the coagulum has been boiled in the acid, cool under the hydrant or in a jar of cold water, and add strong ammonia to alkaline reaction. The light-yellow coagulum which forms in the case of the egg albumin turns to an orange-color. This test is usually given as a universal protein test. Tabulate results on the above suggested series (*a*) to (*e*), noting any variations of the reaction with different proteins. Note variations in the reaction with different strengths of solution of the same proteid.

(4) *The Biuret Test.*—To a suspected liquid add an excess of sodic hydrate; shake well, and to the mixture add one or two drops of a very dilute solution of cupric sulphate. A violet color appears, which, on heating, becomes deeper in shade.

Tabulate results on the protein series (*a*) to (*e*).

(5) Subject each of the series of proteins (*a*) to (*e*) to each of the following reagents, tabulating results:

I. Absolute alcohol.

II. Mercuric chlorid, saturated solution.

III. Tannic acid, saturated solution.

IV. Silver nitrate, 10 per cent solution.

On which of the protein solutions would one get a precipitate with silver nitrate independent of the presence of protein?

(6) *The Diffusibility of Proteins.*—Fill dialyzers with proteins above studied. On the following day test the diffusates for protein.

Experiments and Observations.—(I) What reagent may best be used to determine whether or not any of the egg albumin has diffused through the animal membrane?

(II) How may one determine whether or not any of the salts of the egg albumin have diffused through the membrane?

(III) In the case of the solution of acid albumin is there any contraindication against silver nitrate as a reagent to determine whether protein has diffused?

(IV) What tests would be most reliable in these cases to detect the presence of protein in the diffusate?

(V) Would a trace of protein in the diffusate necessarily demonstrate the diffusibility of these proteins through the walls of the alimentary tract? If not, why not?

(VI) What tests may be used to determine the presence of gelatin in the diffusate? Is gelatin diffusible?

(*a*) If peptone is diffusible, the diffusate will certainly contain peptone. Do peptone and proteoses respond alike to all the general tests for proteoses?

(*b*) How may peptone be separated from the proteoses? What single reagent is indicated in the case?

(VII) Demonstrate the diffusibility of peptone.

III. MILK

1. **Materials.**—One liter of fresh whole milk, one liter of milk for the preparatory steps of the demonstration.

2. **Preparation.**—(1) On the day before the demonstration fill a 500 c.c. open-mouthed cylinder with milk and put it in a cool place.

(2) Three days before the demonstration weigh out 10 grams to 50 grams of whole milk in a platinum dish, or in a thin porcelain dish. Place it in a drying oven at 90° C. to 95° C., and dry to constant weight. Record the dry weight.

(3) Before the hour of demonstration burn the residue by bringing the dish which contains the dry solids to a red glow in a Bunsen flame, allowing ample access of oxygen. After the dish and the white ashes have cooled in a desiccator, take the weight. All of these weights should, of course, be taken upon an analytical balance.

(4) Fill a dialyzer with diluted milk one day before the demonstration.

3. **Experiments and Observations.**—(1) What proportion of milk evaporates at the temperature above suggested? It may be taken for granted that this proportion represents practically the water of the milk.

(2) Of the solids of the milk, what proportion is organic and what proportion is inorganic?

(3) What bases predominate in the ashes?

(4) What is the character of the organic constituents of milk?

(*a*) Note that the milk that has been standing has separated into two layers, an upper yellowish layer and a lower bluish-white layer.

(*b*) Draw off with pipette a few cubic centimeters of the cream, and in a test-tube add an equal volume of osmic acid. To a few drops of olive oil in another tube add osmic acid. Shake both tubes vigorously. Osmic acid has the same effect upon cream as upon olive oil. The cream is, in fact, fat in physiological emulsion. Quantitative examination shows that about 4 per cent of milk, or $\frac{4}{13}$ of the solids of milk, consists of fats in which olein predominates.

(5) Fill a siphon with water and introduce it through the cream to the bottom of the 500 c.c. cylinder; draw off 300 c.c. of the milk; add to it 4 volumes of water; slowly add 1 per cent acetic acid, while stirring with a rod until the casein separates as a flocculent, copious precipitate. After the casein has partially settled, decant off a few cubic centimeters of the supernatant liquid and subject it to the Fehling test. The abundant precipitate indicates the presence of a reducing sugar. It is milk-sugar, or lactose.

(6) Wash the casein by the repeated addition of water, followed by decantation; pour it into a linen sack or a towel and

press out the water; further, extract the water with absolute alcohol; extract the remnant of fat with ether; dry in the air. The white granular material that remains is nearly pure *casein,* the most important protein of milk, and represents nearly 4 per cent of milk.

(7) Heat 100 c.c. of the fresh milk in a beaker. Before the boiling point is reached a membrane gathers upon the surface of the milk. This membrane represents the *lactalbumin* of the milk, which has been coagulated by the heat and has collected in the membranous coagulum at the surface. The lactalbumin represents only a small proportion of the milk protein. Subject the membrane to the xanthroproteic test to demonstrate that it is a protein.

(8) Dilute fresh milk to one fifth normal and subject it to the following tests, recording results:

(*a*) Trommer's test.

(*b*) The xanthoproteic test.

(*c*) The biuret test.

(9) Fill a dialyzer with the diluted milk. One day later examine the diffusate—

(*a*) For any of the inorganic constituents of milk.

(*b*) For the carbohydrate constituents of milk.

(*c*) For the protein constituents of milk.

(*d*) For the fatty constituents of milk.

(10) Formulate in a series of concise statements the facts demonstrated regarding milk:

(*a*) Its chemical constituents.

(*b*) Its physical properties.

IV. THE PROPERTIES OF FATS

1. **Materials.**—Olive oil, cream, butter, and cotton-seed oil.

2. **Experiments and Observations.**—(1) *The Osmic-acid Test.*—Place in test-tubes a small amount of each of the above foodstuffs; add to each a few cubic centimeters of osmic acid. A characteristic reaction takes place, the result of which is a deep brown coloration of the fat. If the conditions are favorable the stain deepens into a sepia black. The cream has protein admixtures; note the variation of the reaction.

(2) *The Solubility of Fats and Oils.*—Prepare two tubes each of olive oil and of tallow; treat each material with absolute alcohol and with ether. It will be found that both of these reagents are solvents of fats and oils. The alcohol, however, dissolves very much more of the fat or oil when warm than when cold, as may be demonstrated by making the alcoholic solution with the tube immersed in boiling water; after the alcohol seems to have reached the limit of solution at that temperature, immerse the tube in cold water. A large part of the dissolved oil instantly separates out, but will readily redissolve on again immersing the tube in the boiling water.

(3) *The Saponification of Fats and Oils.*—(*a*) To about 2 c.c. of olive oil in a test-tube add 1 to 2 volumes of a 25-per-cent solution of sodic hydrate. Shake the mixture vigorously; it is evident that a chemical reaction is in progress. The fat is undergoing the process of *saponification.* A complete and typical saponification requires a more careful apportionment of the amount of oil and of alkali used, and an application of heat.

(*b*) Repeat the experiment, substituting a 25-per cent solution of potassic hydrate. The result is similar.

(*c*) What is the chemical formula of palmitin? Of stearin? Of olein?

(*d*) Write the reaction which takes place in saponification of palmitin; of olein. Note the ready solubility of the products of this reaction in water. (Soaps of the alkalies are soluble.)

(4) *Insoluble Soaps.*—To a solution of soap add any aqueous solution of a calcium, magnesium, or barium salt soluble in water—e. g., calcium chlorid; a curdy, white precipitate separates out. Write the formula of the reaction.

(5) *The Emulsification of Oils.*—Gould defines an emulsion as "water or other liquid in which oil in minute subdivision of its particles is suspended." One may add: More or less permanently suspended. For, if one shake together vigorously 2 c.c. of oil with an equal amount of water in a test-tube, he is able to bring about a minute subdivision and temporary suspension of the oil in the water. While the oil is in this temporary physical condition it has the white color typical of emulsions in general. In a few minutes, however, the particles, as they rise to the top of the

liquid, coalesce into minute globules, and finally into larger and larger globules, then into a homogeneous, supernatant oil-layer.

(*a*) Add to the mixture above described 2 or 3 c.c. of strained egg albumin; shake vigorously. One observes the same minute subdivision of the particles, but they show no tendency to coalesce on standing; the suspension is *more or less permanent.*

Why do not the particles coalesce? In what respects is this emulsion unlike milk?

(*b*) To 2 c.c. of olive oil add 2 c.c. of syrupy solution of any gum—e. g., gum acacia; shake the mixture thoroughly. An emulsion will be formed. What characteristics has this emulsion in common with emulsion (*a*)?

(c) To 5 c.c. of cotton-seed oil containing a little free fatty acid add 10 drops of strong sodium carbonate solution and shake. A good stable emulsion is made in this way.

In what way is this emulsion different from those which precede? Which one of the emulsions given above is most like the emulsions formed in the small intestine?

(*d*) What materials present in the small intestine tend to promote emulsification of fats?

(6) *The Diffusibility of Fats or their Derivatives or Modifications.*—Fill five dialyzers as follows:

(*a*) Milk.

(*b*) Solution of soap.

(*c*) Ten-per-cent glycerin.

(*d*) Emulsion (5, a).

(*e*) Emulsion (5, c).

Complete the observations on the following day, determining what derivations or modifications of fat or oil are diffusible. How may the presence of soap in the diffusate be determined?

B. EXPERIMENTAL CHEMISTRY OF FOODS

The student, having familiarized himself with the chemistry of foodstuffs, is equipped to proceed with a study of food materials as they are found in the markets. Throughout these chemical tests, outlined below, the student should have before him the tabulated chemical analyses given in the body of the book.

I. CEREALS

1. **The Grains.**—Take kernels of wheat, corn, rice, oats, and rye; soak them for several hours, perhaps even boiling them for a time. Dissect these grains carefully with pen knife and dissecting needles, separating coats, germ, etc. If the facilities are at hand, make a very thin slice of the soaked grain with a razor and study the section under the microscope, making out the different coats of the grain and finding the starch grains. These latter may be stained with dilute iodin and studied under the microscope.

2. **Meals and Flours.**—These meals and flours from the cereals may be studied chemically by making a paste and subjecting this to a test for starch, sugar, protein, and fats, tabulating results.

3. **Breads.**—Several kinds of bread may be subjected to a similar series of experiments, tabulating results and formulating general conclusions.

II. STARCHES

Cornstarch, tapioca, sago, and arrowroot may be tested, not only for starch, but for sugars, proteins, and fats. These experiments will demonstrate to the student that the foods in question are practically pure starch.

III. ROOTS AND TUBERS

Potatoes (white and sweet), beets, parsnips, turnips, and onions should be subjected to tests for starch, sugar, and proteins, tabulating results.

Weight before and after drying will show water content and solids. Weight before and after burning will show organic and inorganic materials.

IV. GREEN VEGETABLES

Cabbage, spinach, vegetable marrow, tomatoes, lettuce, celery, rhubarb, watercress, cucumbers, asparagus, and brussels sprouts. Any or all of these, and perhaps other green vegetables, may be subjected to tests for starch, sugar, and protein, tabulating the results. A study of thin sections under the microscope would add

to one's knowledge of the structure and of the location of the starch granules, if these are present. Weighed portions may be dried in an oven and reweighed to determine the percentage of water. The dried portion may be burned in a platinum dish. The weighed ashes will show the inorganic material. The amount of organic material may be determined by taking the difference between the dried matter and ash.

V. FRUITS

1. **Acid Fruits.**—Lemon, pineapple, cranberries, gooseberries, apples, may be tested, first, as to sugar. Litmus paper will show the presence of acid. The actual quantity of acid present would have to be determined by neutralizing it with a known strength of a solution of sodium hydrate. The more sodium hydrate required to neutralize the acid, the greater the amount of acid.

2. **Sweet Fruits.**—Dates, figs, prunes, and raisins may be tested for sugar. The quantity of sugar present may be roughly determined by the quantity of precipitate. An accurate determination of the sugar present may be determined by a careful measurement of the amount of Fehling's solution, reduced by the sugar.

3. **Bland Fruits.**—Pears, melons, bananas, may be tested as to starch and sugar.

All of the above-named fruits, and many others, may be tested as to amount of water and solids. The solids in turn may be tested as to the proportions of organic and inorganic materials, following the methods set forth above.

VI. NUTS

Almonds, Brazil nuts, filberts, hickory nuts, pecans, English walnuts, black walnuts, chestnuts, may be tested for starch, sugar, proteins, and fats. Those nuts in which starch is found are more wholesome and easily digested if cooked before eating. Nuts which do not have starch do not need cooking.

VII. LEGUMES

1. **Dried Legumes.**—Navy beans, dried peas, dried lima beans, lentils, and peanuts. These seeds should all be soaked and per-

haps boiled for some time in order to facilitate the experiments. Dissecting the soaked seeds, one may remove the skin and find the seeds separated into two seed leaves, or cotyledons, joined by a tiny stem and rootlet. A thin slice may be studied under the microscope to show the location of starch granules.

Subject the crushed legumes to tests for starch, proteins, and fat. Tabulate results. Water content, ash, and organic substance may be determined as above outlined.

2. **Fresh Legumes.**—Shelled green peas, string beans, shelled green beans, canned peas, canned lima beans, may be subjected to the tests for starch, sugar, and proteins, tabulating the results.

VIII. ANIMAL FOODS

Various kinds of meat, lean and fat mixed, may be subjected to tests for protein, fat, and carbohydrate. The negative test for carbohydrate emphasizes the fact that meats must be looked upon as a source for proteins and fats. Exceptions to this rule are found in liver, which shows a strong sugar test. If it could be tested immediately following the death of the animal, it would be found to contain animal starch or glycogen. This glycogen changes to sugar under the influence of a diastasic ferment very soon after death. Oysters, clams, and mussels show the presence of carbohydrates. These being represented by the seaweed in the stomach of an animal.

The proportion of water and solids and of organic and inorganic material may be determined as outlined above.

C. EXPERIMENTAL CHEMISTRY OF DIGESTION

Having studied foodstuffs and foods through chemical experimentation, the student is now in a position to study the digestion of foods under the influence of the digestive fluids secreted into mouth, stomach, and intestines.

I. SALIVARY DIGESTION

1. **Materials.**—Bread, fibrin, olive oil, starch paste.

2. **Preparation.**—Chew a piece of rubber or paraffin. The flow of saliva is stimulated; catch the secretion in a beaker; dilute and filter. Label: *Salivary Secretion.*

3. **Experiments and Observations.**—(1) Subject saliva to the Fehling's test. It will be found that the secretion will not reduce the $CuSO_4$ of Fehling's solution.

(2) Subject the starch paste to the same test. The result is negative.

(3) Mix equal volumes of starch paste and salivary extract in a beaker. Keep the mixture at approximately blood temperature for a time. After ten or fifteen minutes subject the mixture to a test with Fehling's solution. If the conditions are normal a copious precipitate of CuO indicates that a change has been wrought in the mixture. The starch has been changed to a reducing sugar by the ptyalin of the saliva.

(4) Put a few crumbs of bread in a test-tube. Starch is an important constituent of bread. Add saliva; keep warm. After ten minutes, test for sugar.

(5) In a similar way proceed to test the action of saliva upon bits of fibrin or shreds of lean meat, a bit of fat, or a drop of oil, noting results.

(6) Boil a few cubic centimeters of saliva; add starch paste; keep warm for ten minutes; test for reducing sugar. What is the verdict?

(7) *To Determine the Course of Salivary Digestion.*—Mix salivary secretion with an equal amount of starch paste. Test a portion at once with iodin and another portion at once with Fehling's solution. Test a portion of the mixture every minute with iodin and another portion every minute with Fehling's solution through a period of at least five minutes.

What is the first change noted in the digestion of the starch?

How many steps may be made out with the means used and under the conditions existing in the experiment?

In what order do the changes occur?

II. GASTRIC DIGESTION

1. **Materials.**—An egg, fibrin, bread, milk, pepsin, hydrochloric acid.

2. **Preparation.**—*Artificial Gastric Juice.*—Prepare a liter or a quart of 0.2-per-cent hydrochloric acid. To half of this add as much pepsin as will lie upon a small penknife blade. While this is not a standard artificial gastric juice, it is well adapted to our simple experiments.

3. **Experiments and Observations.**—(1) To a bit of starch paste of the consistency of jelly add artificial gastric juice; keep warm; note results, if any, one hour later.

(2) To a few drops of olive oil or a bit of fat add a few cubic centimeters of gastric juice; keep warm; note results.

(3) To a bit of fibrin in a test-tube add gastric juice; keep the mixture warm; note the changes which take place during the next five minutes.

4. **To Determine the Active Factors of Gastric Digestion.**—(*a*) To a few shreds of fibrin in a test-tube add a few cubic centimeters of 0.2-per-cent hydrochloric acid. Carefully note results. Will dilute hydrochloric acid dissolve fibrin? Is it possible to digest a proteid without dissolving it? (*b*) To fibrin add a neutral aqueous solution of pepsin. Is solution affected? (*c*) To tube (*a*) add a few drops of a solution of pepsin. (*d*) To tube (*b*) add two volumes of 0.2-per-cent hydrochloric acid. Note results. Formulate conclusions.

5. **The Influence of Division upon the Time Required to Digest Proteids.**—Boil an egg ten minutes; cool quickly; separate hard, coagulated white from yolk and envelopes.

(a) Cut out a one-centimeter cube and put it into a beaker with 40 c.c. artificial gastric juice.

(*b*) Prepare another beaker in which are sixteen quarter-centimeter cubes in 10 c.c. of artificial gastric juice.

(*c*) Into another beaker with 10 c.c. of artificial gastric juice put one quarter of a cubic centimeter of the egg albumin, which has been finely divided by pressing through a fine sieve or grinding in a mortar.

Note time required in each case to completely digest albumin.

Has this any hygienic bearing?

6. **Steps of Gastric Digestion.**—(*a*) Pass coagulated egg-white through a fine sieve; put half teaspoonful of the divided egg albumin in fifty cubic centimeters of artificial gastric juice. Test the liquid every five minutes for an hour with a view to determining the presence in the liquid of acid albumin, of the proteoses, and of peptone. In what order and after what length of time do the several products appear?

7. **Digestion of Various Proteins.**—In a series of test-tubes watch the digestion of gelatin, the gluten of bread, the casein of milk, and the myosin of finely shredded fresh meat.

To demonstrate the presence of peptone in these various experiments use the biuret test described in Chapter I of this Appendix.

III. INTESTINAL DIGESTION

1. **Materials.**—*Glycerin Extract of the Pancreatic Ferments.*—One hundred cubic centimeters of ox bile. Starch, fibrin, olive oil, milk, and bread.

2. **Preparation.**—To make artificial pancreatic juice take one volume of the glycerin extract, add 5 or 6 volumes of water and sufficient sodium carbonate to give the mixture a distinctly alkaline reaction.

3. **Experiments and Observations.**—(1) To starch paste add artificial pancreatic juice; keep the mixture warm. After a short time test a portion of the mixture with iodin and another portion with Fehling's solution, noting results.

(2) Test the action of artificial pancreatic juice on fibrin. If no influence is noted we will understand it is because trypsin of the pancreatic juice lacks the activating agent furnished by the *succus entericus*—namely, the enterokinase.

(3) Mix a few cubic centimeters of neutral olive oil with an equal volume of the artificial pancreatic juice. Shake the mixture vigorously. No permanent emulsion is formed. Place one half of the mixture in the incubator or a jar of warm water. After an hour examine again, shaking vigorously. This time the oil will be readily emulsified. The explanation of this is that during the hour the lipase of the pancreatic juice had changed

some of the fat into fatty acids and glycerin. The former readily enters into chemical combinations with the weak alkali, forming soaps. These in turn emulsify the unchanged fats, as was shown in a preceding section.

(4) To the second part of the mixture add an equal volume of bile; shake the mixture vigorously. A good emulsion is formed. How is this emulsion formed? What factor does the bile add? What is the relation of Experiment 4 to Experiment 3? Pancreatic juice contains a fat-splitting ferment whose action liberates fatty acids.

(5) *To Test the Action of Bile on Foods.*—(*a*) To starch paste add several volumes of dilute bile; shake thoroughly and note results. Is the starch digested? (*b*) To fibrin add bile. Is it digested? (*c*) To oil which contains free fatty acids add bile; shake the mixture vigorously. Is it emulsified? (*d*) To neutral oil add bile; shake the mixture vigorously. What is the result?

INDEX

INDEX

(2)

THE END